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SQUINT

ITS PHYSIOPATHOLOGY AND SURGICAL TREATMENT *

OTTO BARKAN, M.D.

HANS BARKAN, M.D.

HARVEY O. RANDEL, M.D.†

AND

H. GORDON SMITH, M.D.

SAN FRANCISCO

Since strabismus was described by the earliest medical writers its nature has been the subject of much controversy. Many attempts have been made to explain the problem of squint, especially its origin and development. Many valuable contributions have been added from time to time. Worthy hypotheses have been promulgated; numerous ideas as to its etiology have been followed by many ingenious methods for its correction. The three outstanding hypotheses that have enjoyed popularity are: (1) the muscular hypothesis, (2) the accommodation hypothesis of Donders,[1] and (3) Worth's[2] fusion hypothesis. These hypotheses are so well known to ophthalmologists and are so widely published that repetition is unnecessary. Each hypothesis contains truths, but none offers a plausible explanation for the origin and development of all cases of squint. Each hypothesis has many advocates among the leading members of the profession, but the very multiplicity of the explanations denotes the inadequacy of each.

During the past decade the idea of general nervous instability (including heredity) as an underlying factor in the production of squint has been received with increasing favor, as it is recognized that none of the hypotheses by itself is sufficient to explain the clinical state of

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* From the Stanford University Medical School.

† Work done in partial fulfilment of the requirements for the Master of Medical Science degree, University of Pennsylvania.

1. Donders, F.: Anomalies of Refraction and Accommodation, London, 1864, pp. 292, 293, 294, 295, 301 and 303.

2. Worth, C.: Squint, Philadelphia, P. Blakiston's Son & Company, 1920, p. 53.

squint.[3] Landolt [4] pointed out that generations of association of accommodation and convergence have so tied these functions in phylogenetic relationship that defects in one function will also be manifest in the other. In addition to extensive contributions by Parinaud,[5] Worth,[6] Zentmayer,[7] Peter,[8] Stevens [9] and Savage,[10] there is one by Duane [11] in which he stressed the dissociation between the convergence and divergence functions. Stuart [12] explained squint as the result of disturbance of the complex act of proper coordination of the stimuli sent in to the centers of convergence; he saw in this view an argument against the fusion hypothesis. He averred that exercise of the fusion faculty for twenty minutes a day for a few weeks would not be sufficient to make it function properly ever after. He suggested that an objection to the muscular hypothesis is that the muscle cannot be at fault because there is no limitation of movement in recent cases, the eyes straighten in sleep and under general anesthesia, and many cases of squint are cured by glasses. Of the advocates of the fusion hypothesis one may ask: Why does fusion break down after three or four years and allow the eyes to cross? And of Donders' followers: Why do not all hyperopes squint? The majority, and often the worst, do not; besides, many patients with squint have no hyperopia, and some patients who have an internal squint are even myopic.

Van der Hoeve [13] explained in a most interesting way why all people who manifest the same amount of hyperopia do not exhibit the same angle of squint; most persons with hyperopia hold their squint latent through the dissociation of the normal relation of accommodation and

3. The term "squint" as used in this paper is synonymous with concomitant convergent squint, although in general principle the conclusions drawn also apply to divergence, heterophoria and paralysis.

4. Landolt: Arch. d'opht. **35**:416, 466 and 529, 1915.

5. Parinaud, H.: Le strabisme et son traitement, Paris, O. Doin, 1899.

6. Worth, C.: Squint, ed. 6, Philadelphia, P. Blakiston's Son & Company, 1929.

7. Zentmayer, W.: The Present Status of the Etiology of Squint, J. A. M. A. **55**:118 (July 9) 1910.

8. Peter, Luther C.: Extra-Ocular Muscles, Philadelphia, Lea & Febiger, 1927.

9. Stevens, G. T.: Motor Apparatus of the Eyes, Philadelphia, F. A. Davis Company, 1906.

10. Savage, G.: Ophthalmic Myology, Nashville, Tenn., 1904; Ocular Muscles, in Wood: American Encyclopedia, Chicago, Cleveland Press, 1917, vol. 11, pp. 8096 and 8097.

11. Duane, A., in Fuchs: Textbook of Ophthalmology, ed. 6, Philadelphia, J. B. Lippincott & Company, 1917.

12. Wilkinson, O.: Strabismus, Its Etiology and Treatment, St. Louis, C. V. Mosby Company, 1927.

13. van der Hoeve: Beiträge zur Lehre vom Schielen, Wiesbaden, 1902; Arch. f. Augenh. **46**:172, 1902-1903.

convergence. If the hyperopic person were to converge as much as he accommodates, he would squint and see double. As most persons possess a distinct aversion to diplopia, which may be termed diplopia-phobia, every effort is made to overcome it. This may be accomplished in either of two ways: by bringing the two images together or by excluding one of them. The former will be accomplished if the angle of squint is not large and the fusion tendency is potent; the latter if the angle of squint is sufficient to prevent the blending of the images or if there is absence or diminution of the fusion faculty. This horror of diplopia, designated as diplopia-phobia, stimulates into action the senso-motor apparatus of the eyes and adds to the refractive squint an additional squint or "flight strabismus." The presence of this additional flight strabismus explains why correction of the accommodative squint in cases of prolonged duration only partially remedies the deviation, and why in the presence of the same amount of hyperopia the squint angle may be of varying degree, depending on the amount of flight strabismus necessary to avoid diplopia in the individual case.

A general law in neuropsychiatry is that if a burden is intolerable, function is given up completely, but that if it is rendered tolerable, efforts at function are again in evidence. We believe that this lack of attempt may be construed as the cause of the conversion of a phoria into a tropia, and also that it may cause further development of the tropia.

To our mind, Sherrington's [14] law of reciprocal innervation [15] might with benefit be applied to the neuromuscular apparatus of the eye in cases of squint. This application opens new avenues of thought and may bring nearer a solution of the underlying factors. Observations by O'Connor and our own researches have confirmed us in our belief that strabismus of relatively recent origin is in the nature of a habit spasm, that is, contraction and relaxation. According to Sherrington's law, such a contraction and relaxation would be inclined to persist, and the longer it remained the greater would be its tendency to perpetuate itself. These cases of recent origin comprise a group which shows no limitation of movement such as results from contracture of the internus or attenuation of the externus, and yet is slow to respond to orthoptic treatment. This would explain the varying results obtained with the same type of operation in different cases, with the same degree of preoperative deviation. We believe that lack of consideration of this element has probably been the commonest cause of failure of corrective measures.

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14. Sherrington: The Integrative Action of the Nervous System, London, Constable and Company, Ltd., 1909.

15. Stimulation of the center of one movement produces inhibition of the center for the opposing movement and vice versa.

We have been fortified in this belief by the use of the Cinch shortening method of O'Connor.[16] This operation affords a means of shortening a tendon permanently by a known amount, and to our knowledge it is the only method by which this can be accomplished. It offers, therefore, an experimental means of investigating the underlying cause of squint; it is as such, as well as from a practical therapeutic standpoint, that we present it here.

The reduction of the degrees of arc by operation in cases exhibiting the same amount of deviation varies considerably in different subjects. This is true not only in cases in which the difference of duration is sufficient to permit of anatomic changes of varying degree, but also in the class of cases in which structural changes of the adnexa have not yet developed. In the latter functional types, in contradistinction to those of acquired anatomic defects, one finds different degrees of effect from the same amount of shortening; in our opinion, this can be explained only by the more or less pronounced degree of habit contraction and relaxation spasm. In early cases, we have found anatomic anomalies rare, which suggests that congenital mechanical anomalies are the most infrequent cause of squint. It is true that the varying potency of the fusion faculty would, to a marked extent, influence the ultimate effect of tendon shortening in younger patients, but in our experience the varying effects in different persons, as well as in the same person during the course of his convalescence, do not entirely conform to the controlling influence of this fusion tendency. We have been impressed further by the varying amounts of resistance to traction of muscles under general anesthesia in the type of case mentioned. Cases in which a refractive error might have been a factor were carefully eliminated in arriving at these conclusions.

In addition, therefore, to the fusion faculty and in the absence of structural changes, there appears to be a spastic element which accounts for the variation of effect. In our opinion, this is a habit impulse of contraction and relaxation.

Among the innervational hypotheses Parinaud stressed excess of innervation of convergence, a kind of contracture, as determining convergent squint. Duane emphasized excess of convergence or an insufficiency of divergence. Our observations suggest a solution on the basis of Sherrington's law, which offers a more concise physiologic conception simplifying the problem and at the same time indicating rational therapy. The latter should consist of an early operation to break through this impending, or developing, habit spasm of contraction relaxation. This can be accomplished by the Cinch shortening procedure without any of the disadvantages or risks of other operations.

16. O'Connor, Roderic: A New Shortening Technic, Tr. Sect. Ophth., A. M. A., 1916, p. 236.

By operation the habit impulse is interrupted, and the eyes are placed in a position that closely approaches parallelism. The resistance being lessened toward the perpendicular to the line of regard, the former intolerable burden is now brought within the range of the function of fusion. With the development of annoying symptoms (diplopia), as though in consideration of a choice of evils, the eyes follow the path of least resistance and themselves make an effort toward parallelism. Even when amblyopia exists, operation on either eye breaks the habitual spasm and loss of effort, thereby establishing a new mechanical arrangement and relation, and subsequently gives a new system of automatism which tends to keep the alinement intact.

It has been our practice to operate irrespective of age, as soon as it can be determined that orthoptic treatment and glasses will not remedy the deviation. After consultation with a neurologist and a pediatrician regarding constitutional disturbances and nervous stigmas, the eyes are mechanically placed in parallelism by operation. If necessary, orthoptic training is now instituted. In our experience, fusion training before operation is of doubtful value, even in cases of recent origin and of low degree. However, the presence or absence of fusion tendency has a decided influence on the success of operation and on the achievement of single binocular vision. In the patients of our series, we commonly observed that an initial undercorrection of from 5 to 10 degrees disappeared after several days as the result of the innate desire for single binocular vision. Before operation these patients had fusion with amplitude on the amblyoscope when it was adjusted to the angle of their squint.

In the past, advancements, resections, tucks, with or without recessions, or partial or complete tenotomies have been the operations preferred by the majority of ocular surgeons. The operation needed is one that is safe and effective, combined with simplicity of performance. To our mind, the nearest approach to this ideal is the Cinch method of shortening.

The advantages of this method were emphasized by O'Connor,[11] its originator, in 1916, before the Section of Ophthalmology of the American Medical Association, and in 1926 before the Academy of Ophthalmology and Otolaryngology.[17] We are adding additional observations that seem to warrant special mention and further improvements in the technic which the originator has permitted us to publish. We are convinced that the advantages of the Cinch shortening operation, such as the preservation of the tendon insertion and the absence of sutures, are so evident that the time will come when it will be universally employed.

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17. O'Connor, Roderic: Tr. Am. Acad. Ophth. **31**:155, 1926.

We believe that any operation that disturbs the primary insertion of a muscle is to be avoided if as effective a correction can be obtained by leaving the insertion intact. The insertion of tendons is rarely anomalous. The anatomic and physiologic requirements are correlated in surprising ways, and the breadth and sites of attachments are in proportion to the needs of rotation and control. An attempt to improve on natural insertions should be the last resort.

In advancements not only is the insertion sacrificed, but the sutures tend to cut through the tendon or muscle fibers or to pull out from the sclera, thereby causing malinsertions, torsions, etc. The immediate effect is certainly not the ultimate one, and the surgeon can only grossly estimate the end-result. Even perforation of the sclera has been reported in children. Resections are good operations but are open to similar criticisms, for unless combined with a recession or tenotomy, they are usually insufficient unless the squint is of low degree. As in advancements, the immediate result is by no means the end-result.

Tucking operations preserve the normal tendon insertion, but in most instances are insufficient in themselves to correct more than minor deviations. Ligation permits of slipping and sloughing with a resultant loss of effect.

To date, therefore, it seems evident that the ideal operation is the Cinch shortening procedure. The present operation differs in technic from that described in 1916. At that time it was recommended, after a double hitch had shortened the marginal bands, to advance the central tongue to its original insertion. The principal objections to this operation were: 1. It did not permit of accurate calibration. 2. After the marginal bands had been shortened in certain frail attenuated tendons, there was little of the central tongue left to advance. 3. Adhesions formed between the central tongue and the sclera. In the present operation these disadvantages have been eliminated.

Most of our later results were obtained with but one operation, and in no instance was it necessary to perform more than two operations to obtain the desired result. Bauer and Black dermal sutures, either fine, medium or coarse, are employed, although, in phorias of low degree, medium will suffice. The central tongue is not advanced; it is simply a tendon shortening accomplished by splitting the tendon into as many strands as is consistent with the amount of shortening desired.

TECHNIC

A curved conjunctival incision, 12 mm. in length, is made over the tendinous insertion of the external rectus and at right angles to it. The flap is bluntly dissected well back. The capsule is nicked at one border. A strabismus hook is passed underneath and the entire tendon is lifted on it. The capsule is dissected

off entirely. The separator is passed beneath the tendon which is split into as many bands as is desired, in a direction parallel to the fibers. The number of tendon bands is a matter of surgical judgment; in phorias, from eight to ten will be required; in tropias, from four to six; if the muscles are frail and attenuated, three may be needed, although in one instance we used only two. The tendons will usually be found to be longer and more attenuated than normal. The split should be of sufficient length to permit the passage of the dermal sutures, and the tendon bands should be of approximately the same width. The adventitious tissue is now pushed back and the dermal sutures are ready for insertion. The dermal sutures should be boiled for at least twenty minutes prior to their use. They should be of equal length and knotted at the distal end. A black silk suture is tied around the dermal suture just behind the eye of the needle to hold the needle in place. The dermal sutures are inserted over the first tendon band. In tropia, a double loop is required, and this second loop should be continued over again in the same direction. The loop of the second tendon band is placed by crossing the perpendicular at 45 degrees, continuing the second loop in the same direction, temporally or nasally, and alternating or reversing the direction only on the next tendon strip to be looped, but not until the second loop around the same tendon band has been completed. Loop three is placed similarly to loop one, and loop four similarly to loop two. This makes a zigzag or lattice-shaped line. The dermal loops are now ready to be transferred to the tendon bands. This is accomplished by using counterpressure alternately on either end with a pair of curved blunt forceps, keeping the forceps in line with the tendon and in the same plane. The capsule and areolar tissues which have included themselves in the shortening are now pushed back so that the bunch consists of tendon only. A 000 catgut suture is tied around the base of the bunch, snugly but not tightly, to prevent retransference and to keep it in proximity for healing, that is, for the establishment of lateral contact. The upper end of the dermal suture is cut closely, the lower end is grasped with a hemostat and carried beneath the overlying capsule and conjunctiva to a point in the lower conjunctival fornix, where a buttonhole is snipped and the end of the suture is allowed to emerge. It is cut off about 6 mm. from its point of exit, where it remains tangential to the curve of the lower culdesac and unobserved, covered by the lower lid; the moisture keeps it supple and nonirritating. Closure is made with interrupted black silk sutures. An extra step in the operation may be eliminated by throwing a clove hitch about the margins and looping the central portion as described in the foregoing technic. The first clove hitch should be transferred before the central looping is done, the looping should be drawn taut and the line made to disappear before the last clove hitch is transferred. This prevents the use of much force on the counterpressure, eliminates the use of catgut and saves an extra step in the operation. The hitching produces a slight increase in the amount of shortening as compared with the looping. It is ideal for the tropias, but cannot be used for phorias, as it is apt to overcorrect.

A third method is to unite the margins by clove hitch, using coarse dermal sutures, and triple looping the central section. One dermal suture doubled by this method will produce as much effect as three medium dermal sutures doubled, the double loop and catgut being used. It has the advantage of placing less foreign substance in the eye, but does not permit a graduated effect. We prefer the first method for phorias and the second for tropias; in both instances medium dermal sutures are used.

When the first method is employed and the tendon is divided into four tendon strips, approximately 1 mm. of shortening is obtained for each medium dermal

suture double looped. The shortening being permanent, a moderate amount is all that is required. As previously explained, there are so many factors influencing strabismus that it does not seem feasible to attempt to convert amounts of shortening into arc degrees of effect.

We believe that the operation evolves a better surgical principle than any heretofore evolved for the following reasons:

1. Constriction and tension are entirely avoided; the loops of tendon constrict the dermal sutures and not themselves.

2. The effect is necessarily straightforward; therefore no torsion or vertical deviation can follow, even though the line of looping is continued in the same direction without reversal, as each tendon band is shortened separately.

3. The amount of shortening can be varied, depending on the number of dermal sutures, their size and the width of the tendon bands. The wider the tendon bands, the greater the effect on account of bunching; however, this leaves fewer points of contact in uniting. The size of the dermal suture, coupled with the number of loops around each tendon band, increases or decreases the effect proportionately. The narrower the bands, which necessarily increases the total number, the firmer the union, on account of the increased points of contact.

4. There is no loss of effect at the point of shortening in the tendon. The muscle behind may stretch a variable amount, depending on the pull of the opponent. Overcorrection is not necessary. However, it can be relieved by pulling out separately as many dermal sutures as necessary, thereby reducing the amount of shortening, the ends of the sutures being left to emerge free in the lower culdesac.

5. The procedure may be repeated; the same muscle may be shortened several times if, accidentally, the dermal sutures have been removed before union has become established or if an improper estimate was made.

We observed two operations in which a muscle was shortened a second time; in neither instance were there adhesions between the tendon and the sclera, although capsular and conjunctival adhesions were present. This probably is the result of not splinting with binocular bandages and of allowing the muscle to make its normal excursions, the movement thus preventing adhesions.

It seems plausible that in a shortening operation when the squint has existed over an appreciable length of time, the opponent which shows an excess of tonus or contracture, whether innervational or anatomic in origin, would require some form of operative intervention. A mere stretching would cause temporary paresis and functional loss. Central tenotomies (or myotomies), however, are ideally adapted for

this purpose when combined with the Cinch shortening method. Recession may also be employed in older patients, but is rarely necessary.

The Verhoeff, Todd and similar partial tenotomies cannot be used because the Cinch shortening is too definite and an overeffect would result. An exception is possible, as in two of our cases. In these cases the operation was for cosmetic purposes only, and the patients expressed the desire to have all surgical measures completed at one sitting. Single binocular vision was impossible, as each patient had vision for gross objects only in the nonfixing eye. The patients were at an age when, in all probability, convergence would not be reduced. In these two cases a retaining suture was employed, and the patients were observed several times during the first forty-eight hours to note whether or not an overcorrection was present; had it been, the retaining suture could have been drawn up, and the dermal sutures could have been removed separately as necessary to relieve the overeffect.

It is admitted that, in all probability, central tenotomies have no permanent effect unless pulled against by an advancement, resection or shortening; however, when combined with a Cinch shortening procedure the effect is much greater than if the two operations were performed separately. Where as many as 12 shorteners are employed, a central tenotomy tends to prevent enophthalmus. A central tenotomy (or myotomy) also assists in banishing the habit spasm as heretofore mentioned. The cut fibers retract and the uncut fibers stretch, depending on the tension of the opponent. One or two millimeters of the central tongue may be excised if definite contracture is evident; at a subsequent date, after union has become firm, the marginal bands may be tenotomized, producing a guarded recession without scleral suture. The excision of the central tongue is not compulsory to obtain this guarded recession. A marginal tenotomy six weeks later allows the fibers to retract to the position of the reattached central portion. If doubt exists as to whether the central section reunites, it could be lightly sutured to the sclera after excision of as many millimeters as desired, allowing the marginal bands to take the pull, thereby relieving tension on the central section during the process of healing. In our series of 100 cases, marginal tenotomy was not resorted to, the desired result having been obtained before this operative step was indicated.

The foregoing procedure in its entirety permits of an accurate calibration of both tropias and phorias. It can be performed safely at any age; in addition, this method eliminates the possibility of overcorrection and increase of the original deformity. The reaction is moderate. The dermal sutures are removed after twenty-one days. We have had no case of infection, and it does not seem to occur more frequently than in any other operation for squint. No binocular bandage

is required; after twenty-four hours the monocular pad may be removed, but it is usually continued for from one to seven days.

We are at present engaged in further researches on the physiopathology of squint and on the operative treatment for phorias and paralyses. We hope in the near future to supplement this report with observations and conclusions based on the study of a series of cases which we are not incorporating in the present article. However, in reviewing the cases in this series in which esotropia occurs before the age of 10, the following comparison from the point of view of the age of the subject affords interesting information.

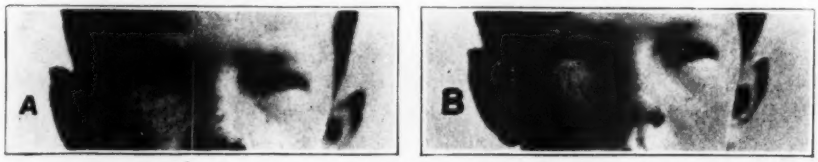

Fig. 1 (case 33).—*A*, before operation; *B*, after operation. The patient (J. F., aged 9) had convergent alternating strabismus in the right eye, amounting to 40 degrees of the arc. Refraction showed: right eye, 0.25 sphere combined with + 0.50 cylinder axis 90 degrees, 0.6; left eye, 0.25 sphere combined with + 0.50 cylinder axis 90 degrees, 0.8. At operation both external rectus muscles were shortened, and central tenotomy was performed on both internal rectus muscles. Third degree fusion and stereoscopic vision are present.

Fig. 2 (case 47).—*A*, before operation; *B*, after operation. The patient (J. H., aged 5) had convergent alternating strabismus in the right eye, amounting to 40 degrees of the arc. Refraction showed: right eye, + 1.25 sphere combined with + 0.50 cylinder axis 90 degrees, 0.6; left eye, + 1.25 sphere combined with + 0.50 cylinder axis 120 degrees, 0.8. At operation both external rectus muscles were shortened, and a central tenotomy was performed on both internal rectus muscles. Third degree fusion and stereoscopic vision are present.

RESULTS OF OPERATION FOR ESOTROPIA

Of twenty-five cases of esotropia in children aged from 1 to 7 years, twenty-three were finished, seven cases showed Worth's third degree fusion, five second degree and four first degree. In three cases, Worth's first degree fusion was absent, and the remaining four patients were too young to undergo stereoscopic examination. In all twenty-three finished cases binocular fixation was obtained.

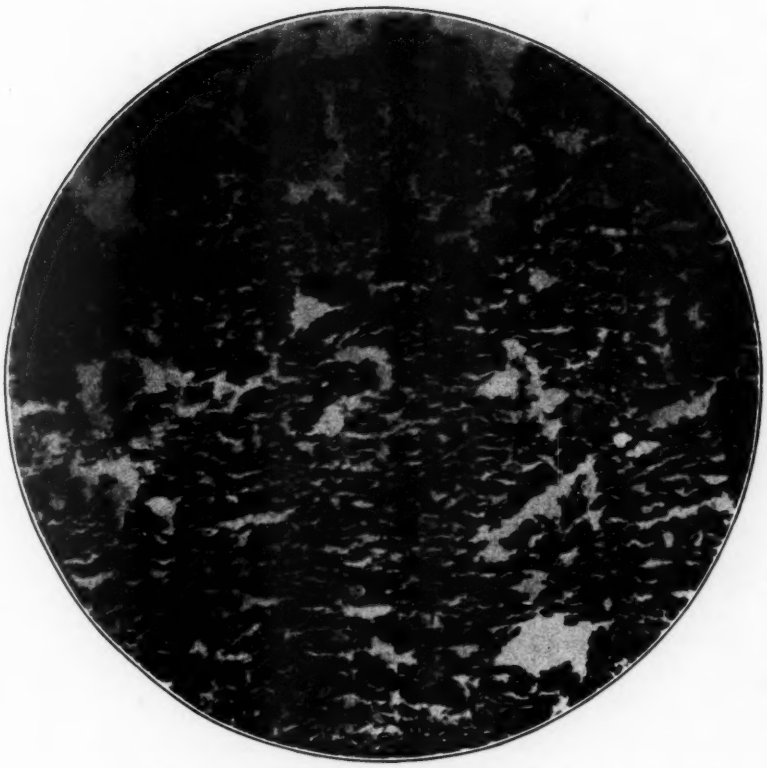

Fig. 3.—Section from right eye of rabbit 1.

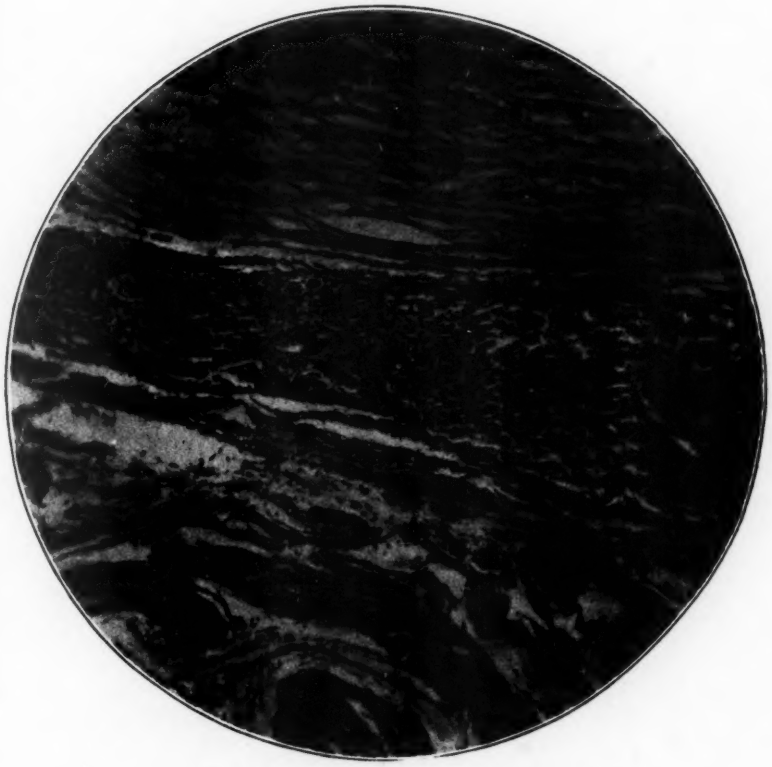

Fig. 4.—Section from right eye of rabbit 3.

Twelve cases in patients from 7 to 10 years of age were listed. Six had third degree fusion and one first degree; one case was unfinished, and in the remaining three Worth's first degree of fusion was absent. All, however, had binocular fixation.

Of fifteen patients from 10 to 30 years, two showed absence of binocular fixation; four had third degree fusion, one second degree fusion and one first degree fusion; in eight cases Worth's first degree of fusion was absent.

Therefore, binocular fixation was obtained in forty-eight of the fifty finished cases of esotropia. The thirty-five patients in this series who were operated on when less than 10 years of age obtained binocular fixation with varying degrees of fusion, whereas of the fifteen patients

Process of Healing in Cinch Shortening Operation

Rabbit	Lapse of Time Before Enucleation of Eye		Pathologic Change	
	Left	Right	Left	Right
1	3 days	6 days	Similar to rabbit 3 (right eye)	Similar to rabbit 3 (right eye) but with predominant purulent infiltration and even area of liquefaction
2	9 days	12 days	Similar to rabbit 1 (right eye)	Similar to rabbit 3 (right eye)
3	16 days	20 days	Similar to rabbit 3 (right eye)	Large granuloma filling a muscle gap; probably the process of muscle healing taking place under optimum conditions; the cell infiltration is essentially an offshoot from the fixed connective tissue cells; small and large round cells, endothelial leukocytes and large phagocytic wandering cells are present; the giant cells are distinctly phagocytic; polymorphonuclear leukocytes are scattered generally
4	3½ mo.	3½ mo.	Ultimate union by scar tissue	Same as in rabbit 4 (left eye)
5	26 days	31 days	Similar to rabbit 3 (right eye)	Similar to rabbit 3 (right eye)

operated on after the age of 10 years, two failed to obtain binocular fixation (their ages were 18 and 22 years, respectively, and the cosmetic result was excellent), and eight failed to show Worth's first degree of fusion.

This review, as well as additional information obtained from our total series, seems to show clearly the advisability of early operation in strabismus with the Cinch shortening method described.

ANATOMICOPATHOLOGIC OBSERVATIONS

In order to determine the process of healing of the recti muscles, an anatomicopathologic study of rabbits was made. Five rabbits were operated on by the Cinch method of shortening; the results are given in the accompanying table.

In the table it will be noted that healing took place by means of granulation processes. In the different specimens various degrees of healing were noted, but the process in all was essentially the same. The ultimate union was by scar tissue. In rabbits 1 (right eye) and 2 (left eye) a predominant purulent infiltration was shown. We are inclined to believe that this was accidental rather than a common or an essential phase of the process. However, healing seemed to take place by means of inflammatory processes.

CONCLUSIONS

1. Strabismus of relatively recent origin is in the nature of a habit spasm or an impulse of contraction and relaxation. According to Sherrington's law of reciprocal innervation, such a contraction and relaxation would be inclined to persist, and the longer it remained or existed, the greater would be the tendency to perpetuate itself.

2. Defective fusion and reciprocal innervation explain the pathogenesis of the great majority of cases of squint.

3. Lack of consideration of these elements is the commonest cause of failure of corrective measures.

4. Rational therapy consists in early operation to break through the impending or developing spasm of contraction and relaxation before structural changes and amblyopia have occurred and while the fusion faculty is still capable of development.

5. This can be accomplished by the Cinch shortening method at an early age without any of the disadvantages or risks of other known operative procedures.

NIEMANN-PICK'S DISEASE WITH CHERRY-RED SPOTS IN THE MACULA

OCULAR PATHOLOGY *

ISADORE GOLDSTEIN, M.D.
AND
DAVID WEXLER, M.D.
NEW YORK

Niemann,[1] in 1914, described a peculiar disease in a female infant, aged 18 months, which resembled Gaucher's disease in some respects, but which was unlike it in others. Several years later, Pick [2] showed that similar cases subsequently reported were not cases of Gaucher's disease, but constituted a clinical and pathologic entity for which he proposed the term lipoid splenohepatomegaly. The specific anatomic feature was the presence of large numbers of vacuolated or "foam" cells in many organs and in most tissues of the body. As the great mass of foam cells are derived from the various kinds of histiocytes, and as the foamy appearance is due to lipoid droplets in the histiocytes, Bloom [3] suggested the term lipoid histiocytosis as a more accurate description of the condition than lipoid splenohepatomegaly, the latter indicating that the process is limited to the liver and spleen, which is not the case. Pick, in turn, noted the inadequacy of this name, since many other cells, such as epithelial, endothelial, smooth muscle, ganglion and glia cells and the cells of Schwann in the nerve sheaths, may contain deposits of lipoid material.

All cases verified anatomically have shown characteristic features. By far the greater number of infants with the disease have been girls. The prominent signs are retardation in mental and physical development, early enlargement of the abdomen and a pale brown discoloration of the skin. The liver and spleen are enormously enlarged. Usually there is unexplained fever. A smear of the blood shows fine droplets in the cytoplasm of many of the lymphocytes. No patient has survived the second year. Some have a history of familial occurrence. Anatomically the picture is distinctive. The liver and spleen contain large numbers of vacuolated foam cells, as do the thymus, suprarenal glands, many lymph nodes and the alveolar walls of the lungs.

The exact nature of the disease is not known. To quote Abt and Bloom,[4] "there are two obvious possibilities—one is the disturbed activ-

* Submitted for publication, Nov. 14, 1930.

* From the Laboratories and Ophthalmological Division of the Mount Sinai Hospital.

1. Niemann: Jahrb. f. Kinderh. **79**:1, 1914.
2. Pick: Ergebn. d. inn. Med. u. Kinderh. **29**:519, 1926.
3. Bloom: Am. J. Path. **1**:595, 1925.
4. Abt, I. A., and Bloom, W.: Essential Lipoid Histiocytosis (Type Niemann-Pick), J. A. M. A. **90**:2076 (June 30) 1928.

ity of the reticulo-endothelial system in the metabolism of lipoids, and the other, a flooding of the entire body with lipoids, mainly lecithin."

Of peculiar interest to ophthalmologists is the fact that cherry-red spots have been observed in the macula in at least five instances of Niemann-Pick's disease, suggesting that amaurotic family idiocy (Tay-Sachs' disease) existed in these patients as well. Knox, Wahl and Schmeisser [5] were the first to report these spots in an infant with Gaucher's disease, but considerable evidence was later presented to show that their case was in reality one of lipoid histiocytosis. Further cases were reported by Hamburger,[6] Bloom,[7] Pick and Bielschowsky [8] and Kramer.[9] The presence of both diseases in the same patient suggested at once that the amaurosis is a manifestation of the generalized disturbance in lipoid metabolism affecting the cells of the central nervous system.

With regard to the intimate cellular changes in amaurotic idiocy, much evidence has been presented in recent years to show that the nerve cells at one time or another contain vacuoles of lipoid material. This has been demonstrated both in the cells of the brain (Sachs and Strauss [10]) and in the ganglion cells of the retina (Grinkler [11]). Bielschowsky [8] studied the brain in Pick's case of lipoid histiocytosis, and noted that the changes corresponded closely to those found in amaurotic idiocy. The difference consisted in the finding of lipoid material in the connective tissue cells of the leptomeninges, in the tela choroidea and in the walls of blood vessels in the brain. Grinkler [11] examined the brain in one of Bloom's cases and found many cells swollen with vacuoles of lipoid material. He thought that these cells resembled in appearance those in amaurotic idiocy, which exhibit earlier rather than advanced changes in structure.

The case to be reported was typical Niemann-Pick's disease with cherry-red spots in the macula in both eyes. Of exceeding interest in the microscopic study of the right eye was the discovery of a group of ganglion cells at the site of the ciliary nerves, close to the optic nerve. These cells, constituting the episcleral ciliary ganglion of Axenfeld,[12] were studied in detail on account of their rare occurrence.

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5. Knox, Wahl and Schmeisser: Bull. Johns Hopkins Hosp. **27**:1, 1916.
6. Hamburger: Jahrb. f. Kinderh. **116**:41, 1927.
7. Bloom, W.: Histogenesis of Essential Lipoid Histiocytosis (Niemann-Pick's Disease), Arch. Path. **6**:827 (Nov.) 1928.
8. Pick and Bielschowsky: Klin. Wchnschr., 1927, p. 1631.
9. Kramer: M. Clin. North America **11**:905, 1928.
10. Sachs and Strauss: J. Exper. Med. **12**:685, 1910.
11. Grinkler: Am. J. Path. **3**:768, 1927.
12. Axenfeld: Ber. d. ophth. Gesellsch., Heidelberg **34**:300, 1907.

THE ACCESSORY CILIARY GANGLION OF AXENFELD

In investigating the function of the ciliary ganglion and nerve system, several authors (Peschel,[13] Bietti [14]) have come on ganglion cells in the course of ciliary nerves in the orbits of rabbits. Axenfeld called attention on several occasions to their occurrence in the human eye, and finally, in 1907, demonstrated as many as thirty in the episcleral tissue and in the superficial fibers of the sclera in the human eye. These formed, in effect, small episcleral ganglions, which he considered sympathetic. Subsequently many eyes were studied for these atypical cells, apparently without success, although the literature contains an occasional reference [15] to the occurrence of these ganglion cells within the ciliary nerves.

REPORT OF A CASE

A Jewish girl, aged 10 months, was admitted to the hospital with a history of difficult feeding and generally retarded development. The important observations on examination were a peculiar brownish pigmentation of the skin and marked

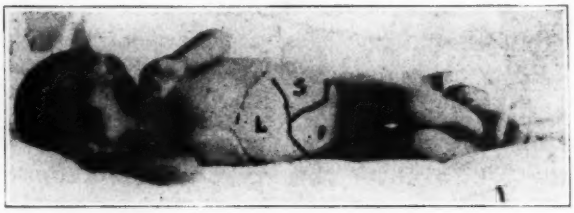

Fig. 1.—Photograph of infant, with extent of enlargement of the liver (*L*) and spleen (*S*) indicated.

enlargement of the liver and spleen, both of which reached the level of the umbilicus. A diagnosis of lipoid hepatosplenomegaly of the Niemann-Pick type was suggested and was confirmed first by the presence of numerous vacuolated lymphocytes in the blood smear and then by the examination of tissue obtained by splenic puncture. Further laboratory data were: hemoglobin, from 46 to 68 per cent; red blood cells, 3,410,000; white blood cells, 18,000, and polymorphonuclears, 62 per cent. Blood estimation showed: cholesterol, 290 mg.; phosphorus, 3 mg., and calcium, 12.2 mg. per hundred cubic centimeters of blood. The total blood fat was variable, its highest mark being 1.43 Gm. The Pirquet and Mantoux skin tests were negative, as was the Kahn test of the blood.

Examination of the fundi by one of us (I. G.) revealed: In the right eye the nerve-head was flat and buff-colored. The cherry-red spot was oval, one-fifth the size of the disk, and had fuzzy margins. The color was brownish-red; in the center, it was much lighter (rose-red). The brownish-red spot appeared larger than those seen heretofore. It was slightly higher than the adjacent retina. About the brownish-red was a gray area, equal in width to the largest dimension of the cherry-red spot.

13. Peschel: Arch. f. Ophth. **39**:1, 1893.
14. Bietti: Arch. f. Ophth. **49**:224, 1899.
15. Ginsberg, in Henke-Lubarsch: Handbuch der speziellen Anatomie und pathologischen Histologie, Berlin, Julius Springer, 1928, vol. 2, p. 302.

Fig. 2.—Upper: right fundus. Lower: left fundus.

In the left eye the disk was flat and rose-colored. Above it was a grayish edematous area two-thirds the size of the disk. At the macula was a rose-red spot slightly larger than the brownish-red area in the right eye, and again lighter in the center. The area about the red spot resembled in size and appearance the corresponding gray area in the right eye and was elevated.

It was noted by Dr. Israel Strauss that the child did not present the clinical symptoms ordinarily seen in amaurotic family idiocy. There being no untoward developments, the child was released from the hospital, soon to be readmitted, however, with signs of pneumonic disease. Following a period of intermittent fever and sepsis, the child died five months after the first admission to the hospital.

Autopsy.—The liver was enlarged to three fingerbreadths below the umbilicus; the spleen, to three fingerbreadths above the umbilicus. The abdominal lymph nodes were enlarged, yellow and flabby. The heart, suprarenal glands, pancreas, kidneys and intestinal mucosa revealed a pale yellow or whitish color on section.

Fig. 3.—Posterior pole of globe, six times actual size, photographed four hours after death. The cherry-red spot and the surrounding gray area, definitely raised, are clearly visible.

Microscopic examination revealed large numbers of pale vacuolated cells in the liver and spleen. Cells typical of Niemann-Pick's disease were found in the lymph follicles of the large intestine, the mucosa of the small intestine and the alveoli of the lung. The cortex cells of the suprarenal glands were filled with lipoid. The pancreas, bladder, heart, uterus, ovary, skin, thyroid and skeletal muscle showed no change. In the lymph glands, almost the entire lymphatic structure was replaced by an accumulation of foam cells.

Examination of the brain (by Dr. Joseph Globus) revealed widespread degeneration of the cells of the parenchymatous elements. The process was seen in the cortex of the cerebrum, cerebellum and spinal cord. The change consisted of swelling of the cells with displacement and disappearance of the nucleus, granular degeneration of the cytoplasm and displacement of the cell processes. The blood vessels showed no evidence of inflammatory reaction. The ganglion cells were

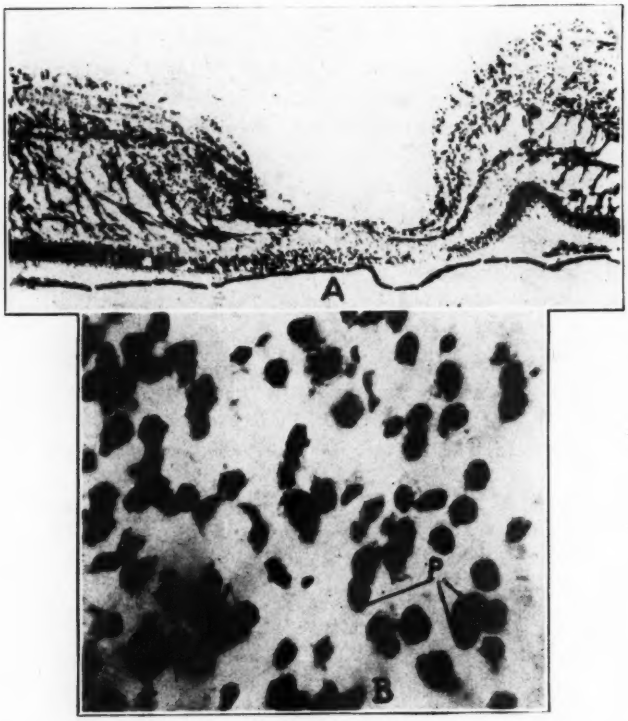

Fig. 4.—*A*, section at the macula, showing edema of Müller's fibers in the internuclear layers (Bielschowsky stain). *B*, group of ganglion cells at the macula, showing various degrees of vacuolation and necrosis. The more intact cells exhibit pyknotic nuclei (*P*).

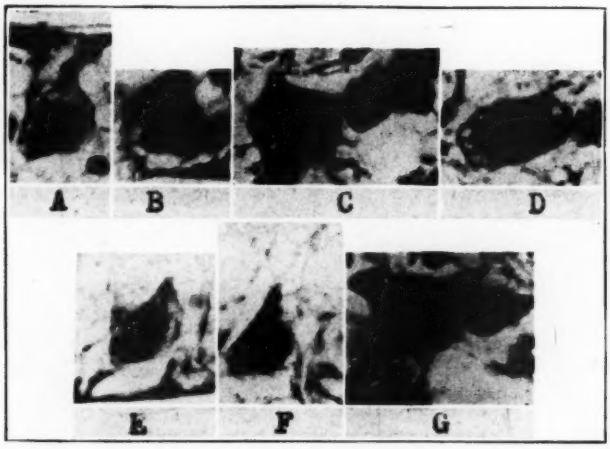

Fig. 5.—Retinal ganglion cells exhibiting various degrees of change: *A*, pyknotic enlarged nucleus. *B* and *C*, enlarged cells with irregularly swollen vacuolated nuclei. *D*, practically total disintegration of nucleus. *E* and *F*, nuclei swollen with vacuoles. *G*, total disappearance of nuclear structure in greatly enlarged cell (cresyl violet stain, oil immersion).

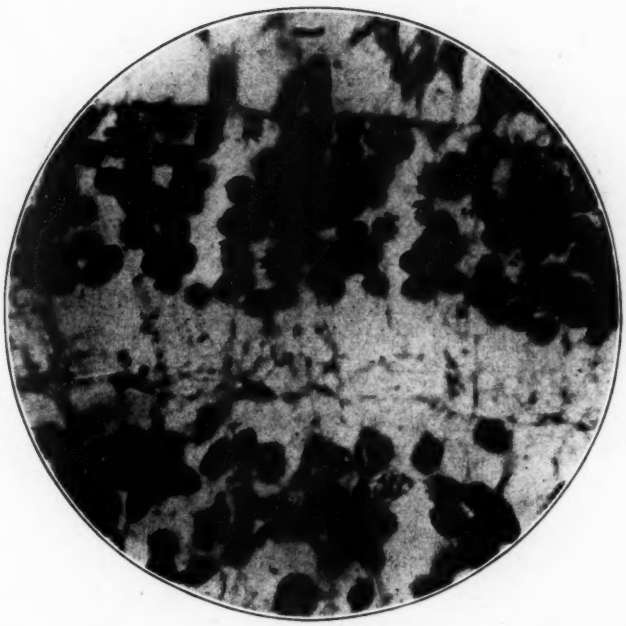

Fig. 6.—Many cells of the outer nuclear layer (above) are honeycombed due to excessive vacuolation. The inner layer (below) shows similar though less advanced changes.

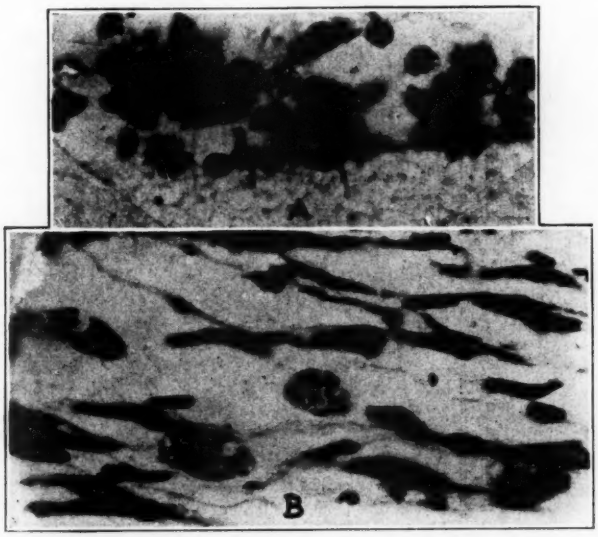

Fig. 7.—*A*, a group of vacuolated cells of the inner nuclear layer. The adjacent cells contain deeply staining nuclei. *B*, a group of cells in the choroid containing pigment granules and vacuoles, probably lipoid (oil immersion).

Fig. 8.—Ciliary vessel adjacent to the choroid with numerous vacuolated histiocytes in its sheath and periadventitial layers. Similar cells are scattered among the fibers of the sclera.

Fig. 9.—*A*, site of the accessory episcleral ganglion (*G*) and its relation to the sclera (*S*) and ciliary nerve (*C*) (Bielschowsky stain). *B*, ciliary nerve in the episcleral tissue; ganglion cells (*GC*) within its sheath.

very large and their cytoplasm was filled with numerous small vacuoles, causing a honeycombed appearance.

The right eye was fixed in Bouin's solution two hours after death, and sectioned in paraffin; hematoxylin and eosin, Bielschowsky's stain and cresyl violet were used.

The structural changes involved the retina, choroid, sclera and episcleral tissues.

Retina: A study of the macula showed a marked swelling of the tissues on each side of the fovea, owing to edema of the internuclear layers. Müller's fibers between the nuclear layers were distorted and separated from one another to a marked degree. This edema extended to the pigment layer, displacing the latter posteriorly (fig. 4*A* and *B*). A few cells in the macula retained their normal structure. In some the nuclei stained deeply (fig. 4*B*). In others the nuclei and

Fig. 10.—Two ganglion cells within the sheath of a ciliary nerve bundle. That to the left shows changes similar to those described in figure 11. That to the right is swollen, and shows more advanced degeneration of the nucleus and cytoplasm than the cells in figure 11.

cytoplasm contained droplets or the entire cells looked cystic, while still others were enlarged, with ill defined, poorly staining nuclear and cytoplasmic fragments. Figure 5 represents characteristic appearances in the cells chosen from various portions of the ganglion cell layer—from pyknosis of the nuclei, to enlargement of the cells and finally loss of identity as a ganglion cell structure. The nuclear layers in figures 6 and 7*A* speak for themselves. This extensive alteration was found in all portions, from the disk to the ora serrata. Here and there were glia cells, apparently infiltrated into the diseased layers, both ganglion cell and nuclear. The rod and cone layer contained no abnormalities.

Choroid: The conspicuous lesion here consisted in the presence of fairly large oval, vacuolated cells, some containing pigment granules. A few (such as the one

to the extreme left in figure 7*B*) bore elongated blunt processes. These cells occurred for the most part singly, scattered throughout all the choroidal layers. Some, however, were close together, forming groups. Occasionally, a large clear pale cell, without a nucleus or vacuoles, was discovered lying free in the layers or in a small vessel close to the capillary layer.

Sclera: Figure 8 shows an arteriole in the sclera before its entrance into the choroid. A large number of large cells surrounded the vessel in its sheath and beyond it. The cells also infiltrated the superficial choroidal layers along the course of the branching vessels and likewise among the radiating scleral fibers. In fact, in all portions of the sclera, up to approximately the level of the equator of the globe, these cells were present between the fibers, being more numerous about the medium-sized ciliary vessels. Under high power these cells were found to contain many fine glistening vacuoles.

The relation of the episcleral ganglion to the sclera and ciliary nerves is depicted in figure 9*A*. The section is close to the nerves at the normal site of entrance of the ciliary nerves. The ganglion cells occurred three to six in a group, and were within a fibrous sheath either by themselves or in conjunction with a few ciliary nerve fibers. Their structure was identical with that of ganglion cells of

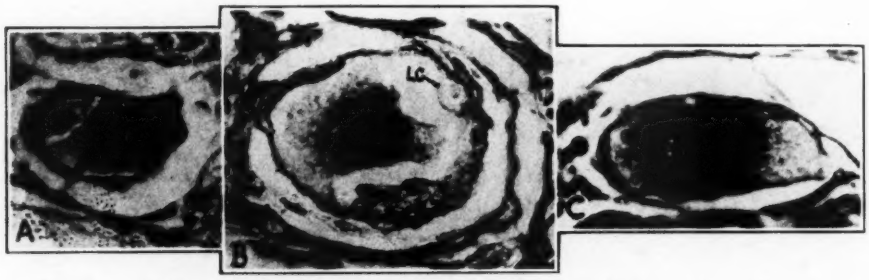

Fig. 11.—Cells of the episcleral ganglion representing various degrees of change: *A*, hyperchromatism of the nucleus and of the Nissl granules of the nucleus and cytoplasm. *B*, swelling of the cell, vacuolation of the cytoplasm and further prominence of Nissl granules. LC is a cell of the ganglion cell sheath swollen with lipoid. *C*, breaking down of nucleolar and nuclear structure and granular degeneration of the cytoplasm.

the ciliary ganglion. In all, a total of fifteen or eighteen were made out, on either side of the nerve. Two were found at a deeper level, just under the superficial fibers of the sclera. Figure 10 shows ganglion cells within the sheath of a ciliary nerve cut longitudinally. Axis cylinders could be demonstrated in several; some bore processes that were probably the proximal ends of dendrites. None could be classed as healthy ganglion cells, there being evidence of nuclear or cytoplasmic degeneration in all. Figure 11*A* represents perhaps the mildest change. The cell was about normal in size but its nucleus and cytoplasm were already undergoing granular degeneration. In *B* the process is further advanced, extending into the axis cylinder, while *C* shows considerable swelling of the cell and a high degree of nuclear and cytoplasmic degeneration.

Optic Nerve: Sections stained for myelin sheaths showed the disappearance of these to a large extent (fig. 12). Almost all the cells of the nerve fiber sheaths showed granular degeneration and precipitation of the cytoplasmic granules. A large number of cells of the glia type, infiltrated into the nerve, showed similar

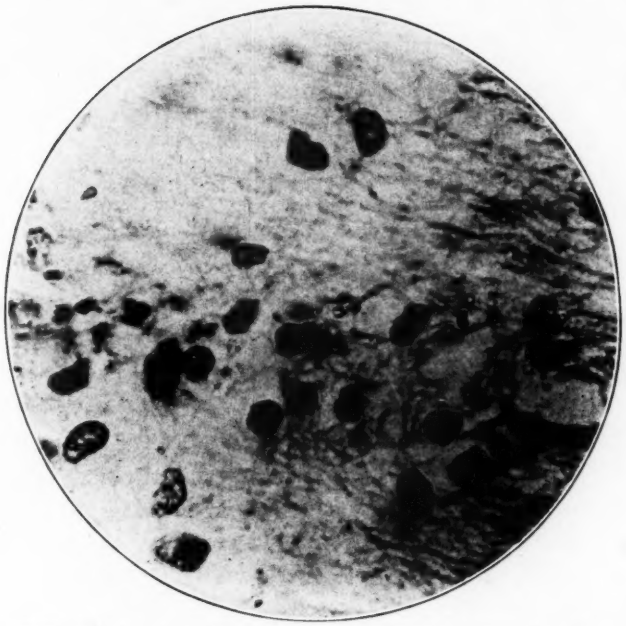

Fig. 12.—Cells of the sheaths in the nerve showing vacuoles in some and precipitation of the granules in others. A few glia cells show similar changes (oil immersion).

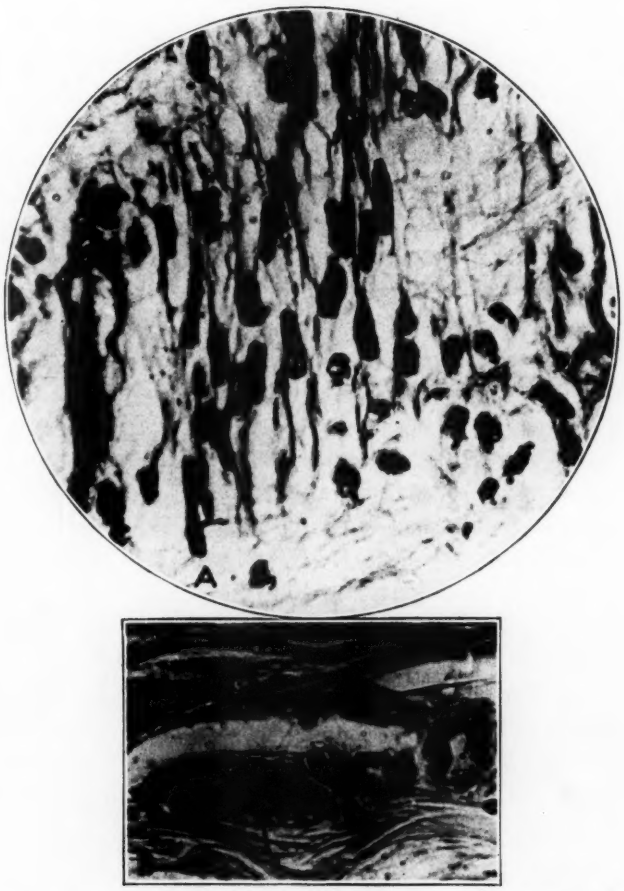

Fig. 13.—*A*, cells of the nerve fiber sheaths and connective tissue septums immediately behind the lamina cribrosa, with numerous droplets in their cytoplasm (foam cells). *B*, foam cell (*F*) in the dural sheath of the optic nerve.

changes. Most remarkable, however, was the conversion of the connective tissue cells in the septums into the foam type of cell. These were elongated or quadrilateral, and contained well defined droplets in their cytoplasm, undoubtedly of lipoid material (fig. 11*A*).

COMMENT

In estimating the particular value of the picture of the fundus in this case, one may perhaps point to the yellowish color of the disk in the right eye as being more indicative than the atypical brownish-red of the macula. The slight variations in color at the macula, as well as variations in the extent of the surrounding edema, should be considered an index more of the degree to which the nerve cells are degenerated than of the specific factor responsible for the degeneration. The yellow color of the disk, which was not typical for amaurotic idiocy, could be interpreted as characteristic of the deposition of lipoid in the sheaths and cells of the nerve fibers in all parts of the body, such as occurs in Niemann-Pick's disease. This color may be attributed to the deposit of lipoid in the glia cells, in the cells of the nerve fiber sheaths and in the cells in the septums of the nerve (figs. 11*A* and 12).

The type of degeneration in the ganglion cell layer of the retina could not be distinguished from that so frequently described for amaurotic idiocy. The widening of the internuclear spaces on either side of the macula, whether due to edema or not, we consider an important factor in the elevation observed clinically about the red spot. In the eyes of normal infants, removed within two to three hours after death and treated similarly, although there is folding of the macular layers, such spacing out and distortion between the layers of nuclei do not occur. Earlier authors adhered to this view, but of late these appearances in the macula in cases of Tay-Sachs' disease have been disregarded in estimating the cause of the grayish elevation. We are in agreement that edema in the ganglion cell layer is a negligible factor, but the increase in dimensions of the internuclear layers, in this case at least, cannot be dismissed as a factor in the elevation observed.

A review of the literature fails to reveal any case in which the cells of the nuclear layers are degenerated to the extent observed in this case. One ordinarily refers to disease of the "ganglion cells" in the retina, meaning the cells of the ganglion layer. Those of the nuclear layers are ordinarily exempt from change. The honeycombed appearance in this case, not observed in Tay-Sachs' disease, may be taken as an indication of the more severe disturbance in lipoid metabolism in Niemann-Pick's disease. The histology of the juvenile type of amaurotic idiocy is essentially a loss or thinning of the outer nuclear layer and a migration of pigment granules into the retina (Stock,[16] Greenfield and Holmes [17]). Specific cellular changes such as were noted in this case are absent.

16. Stock: Klin Monatsbl. f. Augenh. **5**:225, 1908.
17. Greenfield and Holmes: Brain **48**:183, 1925.

The vacuolated cells in the choroid contain pigment, which suggests that their origin is the chromatophores. It is, of course, possible that much of their pigment has been either lost or displaced by vacuoles of lipoid and that they have lost their processes in the degenerative change, somewhat in the manner in which the processes of nerve cells in the brain are displaced under similar conditions. The appearance of an occasional cell bearing a long process suggests such an origin (extreme left, fig. 8). However, we are more inclined to the belief that most of these cells are vacuolated histiocytes which have wandered away from blood vessels and engulfed pigment granules, this in spite of there being no free pigment or signs of inflammation in the choroid. The tendency of histiocytes in this disease to absorb pigment has been noted by Bielschowsky.[8]

The vacuolated histiocytes so prominent about the vessels in the sclera and episclera correspond to those found in this case in other parts of the body. Cells of this type are not ordinarily seen in sections of the eye, but have been demonstrated in animals by means of intravital staining. Histiocytes can then be found in all parts of the eye and with some difficulty in the retina. In inflammatory states they increase in number and may wander considerable distances from their usual source, the walls of blood vessels. In Niemann-Pick's disease they increase in number, and become more prominent owing to their content of lipoid. Only an occasional one was seen in the anterior portion of the sclera and in the ciliary body. Perhaps the compactness of the latter tissue and the absence of loose tissues about the blood vessels were unfavorable to the multiplication and easy recognition of these cells.

Holden [18] studied sections of the ciliary ganglion in a case of amaurotic idiocy and found the ganglion cells to be normal. Setting aside the matter of whether the atypical accessory ganglion described in this case is sympathetic, sensory or a true accessory ciliary ganglion, it is not surprising to find evidences of degeneration, in view of the widespread changes in ganglion cells all over the body. One could almost predict similar disease in the cells of the ciliary ganglion. Such observations as the sensibility of the cornea and the action of the dilator muscle of the iris would be of value in this regard.

Finally, it would seem preferable to restrict the term amaurotic family idiocy of Tay-Sachs to those infants with the usual clinical evidences of this disease in addition to cherry-red spots in the macula. Typical amaurotic idiots do not have an enlarged liver and spleen, nor do they show a blood picture indicative of the more severe disturbance in lipoid metabolism. Similarly, in many cases of Niemann-Pick's disease cherry-red spots in the fundi are lacking. While it is true that

18. Holden: J. Nerv. & Ment. Dis. **25**:550, 1898.

many of these patients are poorly developed mentally, this is as much a characteristic of cases without the macular spots as of typical Tay-Sachs' disease. A distinction on purely clinical grounds, therefore, seems warranted. In the case described, the diagnosis "Niemann-Pick's disease with cherry-red spots in the macula" would be a more accurate estimate of the facts presented.

SUMMARY

The histology of the eye in a case of Niemann-Pick's disease with cherry-red spots in the macula is described, in which an accessory episcleral ganglion was noted. The prominent features were:

1. Degeneration of the ganglion cell layer of the retina, corresponding closely to that described in Tay-Sachs' disease.

2. Vacuolation of the cells of the nuclear layers, causing a striking honeycombed appearance.

3. The presence of pigmented, vacuolated cells in the choroid.

4. The presence of vacuolated histiocytes about the scleral vessels and in the episclera and an infiltration of these cells among the fibers of the sclera.

5. A group of ganglion cells in the episclera, in intimate contact with the ciliary nerves, exhibiting changes similar to those of the cells of the brain and of ganglion cells elsewhere in this case: granular degeneration of Nissl's substance, swelling of the cell and vacuolation of the cytoplasm.

REFRACTION FOR THE PERIPHERAL FIELD OF VISION *

C. E. FERREE, PH.D.
G. RAND, PH.D.
AND
C. HARDY, A.B.
BALTIMORE

Two important reasons might be given for studying the refractive condition of the peripheral field of the eye: (*a*) to study its relation to determinations of acuity in the peripheral field, and (*b*) to study its relation to determinations of chromatic and achromatic sensitivity in the peripheral field. In former studies we have made rather elaborate series of determinations on both of these points. There remains for this study an investigation of the refractive condition of the peripheral field. Another angle of approach has been to complete our study of the variable factors that influence the determination of the limits of the color and form fields. This is, of course, but an aspect of (*b*).

In listing the factors that cause a variation of result for a given person, we find the following: wave length and purity of stimulus, intensity of stimulus, size of stimulus or of angle subtended at the eye, length of exposure to stimulus, method of exposure (moving or stationary stimulus), intensity of general illumination of the retina and state of adaptation, breadth of pupil and brightness of preexposure and of background or surrounding field. To these may be added also method of approach of the limit (ascending or descending series) and method of judging the limit for colors which change in hue in passing to the periphery of the field, e. g., red and green. Among those which cause variability of result from person to person, the following may be mentioned: curvature of the cornea, errors of refraction of the peripheral field, acuity of the peripheral field, age, sex, shape of face, sensitivity of the retina and distribution of sensitivity.[1]

We have already shown in a study of from 125 to 200 cases a distinct effect of the refractive errors of the central field on the size

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* From the Research Laboratory of Physiological Optics, Wilmer Ophthalmological Institute, Johns Hopkins Medical School.

1. The factors that cause variability of result for a given eye produce different amounts of effect for different eyes. To this extent, then, they also contribute to the variability of result from eye to eye.

of the color and form fields.[2] In the present study of the refraction of the peripheral field this relation of refractive error to size of field has not been investigated. The purpose has been to develop a method and to obtain some knowledge of the refractive situation as far into the peripheral field as is possible. It is our hope in the future to study the refractive situation in relation to the extent of the form and color fields.

With reference to our needs or any needs of practical application, the attempts that have previously been made to refract the peripheral field are unsatisfactory for the following reasons: 1. The methods used were either unsatisfactory as to accuracy or so cumbersome as to apparatus and method as to be worthless for practical work. 2. The results were not expressed in a form that has practical meaning or value. 3. The determinations extended but a short distance into the peripheral field.

In considering the refraction of the peripheral field, we are dealing with the effect of oblique incidence of the rays of light on the refracting system of the eye. Clear images are formed by lenses only when the object to be imaged is located on the principal axis of the lens. When the object is displaced from the principal axis a distortion of the image occurs which varies in amount with the angle of displacement of the object or with the angle of incidence of the light on the lens. In general, the effect of varying the angle of incidence is that of adding a weak plus sphere and a strong plus cylinder with its axis at right angles to the plane of incidence. The major effect is thus to create a strong astigmatism. A simple formula for this effect in the two meridians may be expressed as follows:[3]

$$F_1 = \frac{F\ (\mu - 1)}{\mu\ \cos\ b - \cos\ a}$$

$$F_2 = F_1 \cos^2 a$$

In these formulas F represents the focal length of the lens in question; F_1, the focal length in the meridian of least refractive power; F_2, the focal length in the meridian of greatest refractive power; a, the angle of incidence of the light, and μ, the refractive index of the lens. In both

2. Ferree, C. E.; Rand, G., and Monroe, M. M.: Studies in Perimetry: I. Preliminary Work on a Diagnostic Scale for the Form Field, Am. J. Ophth. **9**:95, 1926; Studies in Perimetry: II. Preliminary Work on a Diagnostic Scale for the Color Fields, ibid. **12**:269, 1929; Studies in Perimetry: III. Errors of Refraction, Age and Sex in Relation to Size of the Form Field, ibid. **12**:659, 1929; Studies in Perimetry: IV. Preliminary Work on a Diagnostic Scale with a 0.17° Stimulus, ibid. **13**:859, 1930.

3. Laurance, L.: General and Practical Optics, London, The Orthos Press, 1903, pp. 163-166; ed. 3, 1920, pp. 245-247.

meridians, then, the image is brought nearer to the lens as the angle of incidence increases, very much nearer in the meridian of the oblique incidence and very little nearer in the meridian at right angles to it. The refractive effect for the eye would thus be a slight myopia compounded with a strong myopic astigmatism. The effect on vision is modified, however, by the fact that the distance of the retina from the nodal point of the refracting system decreases rapidly as the distance from the fovea is increased. In the greater number of eyes the effect of this is to bring the retina between the foci in the two meridians or to cause a mixed astigmatism which increases in diopter value as the periphery of the retina is approached. As will be shown later, however, another type of eye is found also, but this type is not of such frequent occurrence.

METHOD AND APPARATUS

For the refraction of the peripheral field, a Zeiss parallax refractometer modified to suit our purpose was used. Like all the objective methods of refraction, the method used with this instrument provides a means of determining the distance of the point or plane in front of the refracting system of the eye which is the anterior of the pair of conjugate foci of the refracting system of the eye. Of this pair the fundus is the posterior focus. Also like the other objective methods—refraction with the ophthalmoscope and with the retinoscope—the method is only approximately correct in principle; i. e., the fundus, and not the percipient elements of the retina, is taken as the posterior focus. The reflecting surfaces which make up the fundus cannot be assumed to have the same location as the percipient elements nor even to sustain an invariable relation to them in the different parts of the eyeground and in different eyes. The distance between these reflecting surfaces and the percipient elements is minute, it is true, but in a refracting system as powerful as that of the eye even minute changes of distance in the posterior focus may become of consequence in the location of the anterior focus. The subjective methods of refraction alone start with the true posterior focus of the refracting system. This is one of the reasons why they should be the final court of appeal in making an accurate refraction.

We find, however, that the subjective method can be used with but indifferent success in the peripheral field. Of the objective methods, that used with the refractometer has thus far been found by us to be the most satisfactory for this work.

In brief, the principle of locating the posterior of the conjugate foci of the refracting system of the eye utilized in the Zeiss refractometer is as follows: At the principal focus of the objective lens of the instru-

ment is placed a transilluminated test object. The rays of light from this test object are therefore collimated by the lens and enter the pupil of the eye as a parallel beam. If the eye is emmetropic, the image will be focused on the fundus (approximately). Likewise when the eye is emmetropic, the light reflected from this surface will emerge from the pupil of the eye as a parallel beam and will be focused by the objective lens of the instrument at the position of the test object. In order to be able to compare the distances of the test object and of the image so formed from the objective lens of the instrument, the principle of parallax is used; that is, the line of view of the examiner is displaced slightly to one side of the principal axis of the refracting system of the eye and objective lens. If the distances of object and image from the objective lens are equal, the image will be superimposed on the test object and will not be visible (emmetropia). If it is nearer to the lens than the test object, the image will be seen displaced to one side of the test object, the side toward the illuminating tube of the instrument (myopia); if it is further from the lens than the test object, it will be seen displaced to the other side, the side opposite the illuminating tube of the instrument (hyperopia). In order to provide for the refraction of the eye in different meridians in the examination for astigmatism, the system can be rotated through 180 degrees and the determinations made at any position within this range. In case the position of the test object and of its image are found not to coincide, the test object is moved until exact coincidence is obtained. The vertex refraction can then be read from a scale which is seen just above the test object. A more detailed description of the instrument is given in the circular issued by the manufacturer.

As the instrument is placed on the market, it is designed only for refraction at the center of the field. As modified by us, it can be used at any point in the horizontal meridian from the center of the field to an eccentricity of 60 degrees temporally or nasally. Beyond this point the image reflected from the fundus is too dim to be distinguished. The instrument as modified for our purpose is shown in figure 1.

As seen in figure 1, the instrument is mounted on a carriage provided with ball and socket casters and made to pivot about a fixed point. The circle described by the carriage is graduated in degrees. The position of the carriage is read by means of a pointer which is located at the back of the carriage in the vertical plane passing through the principal axis of the optical system of the instrument. This pointer passes over the graduated scale. In order that the eye may be located with precision vertically above the fixed point and thus be at the center of rotation of the instrument, a small disk is mounted at the point of intersection of the perpendicular erected at the fixed point with the

principal axis of the optical system. When the eye is in position, the front of the closed lid is in contact with this disk. To maintain the eye in this position, the observer is required to bite a mouthboard in which the impression of his teeth has previously been made and hardened in wax. The disk is then turned out of the way.

In order to facilitate the location of the eye in the desired position, the mouthboard is mounted on a rest provided with up and down, back and forth and right and left adjustments. The adjustments are made by coarse-threaded screws. The screws for the right and left and the back and forth adjustments are driven by small wheels; the screw for the vertical adjustment is operated by a large milled head.

Method of Controlling Fixation and Accommodation.—It is supposed to be possible to use the instrument both with and without a cycloplegic. Both of these conditions have been used in this work. The directions given in the descriptive circular referred to for the refraction of the central field without a cycloplegic are as follows: The patient is directed to look into the instrument with the eye under examination and to fixate the bright clear spot seen in the center of the field. This is for the control of fixation. For the control of accommodation, the test target, which becomes clearly visible when it is located at the patient's far point, is always moved from a position beyond the far point toward the far point. This is to cause the patient to relax his accommodation in the interest of seeing clearly.

We have not found this method to be entirely satisfactory. We obtained more reproducible results, and results that checked better with the subjective methods of refraction, by enlisting the aid of the eye not under examination; that is, by the use of both eyes, better control could be exercised over both fixation and accommodation. The procedure is as follows: When central refraction is to be determined, the eye not under examination is required to look at the smallest detail that it can distinguish on a test chart at a distance of 6 meters. If it is hyperopic or emmetropic, it is fogged to 0.5 diopter of myopia to induce relaxation of accommodation. If it is myopic, it is already fogged for distance. In that case a larger detail has to be selected on the test chart. To guarantee that the eye not under examination is taking the same fixation as the eye under examination when it is looking at the bright dot at the center of the test field, as is required in the use of the instrument, the test chart is so located that the bright spot is seen at the center of the detail which serves for the fixation of the eye not under examination. This satisfies the two essential conditions, namely, that the two eyes are fixating in proper coordination, and that the eye under examination is fixating the bright dot at the center of the test field. In refraction of the peripheral field, the eye

under examination cannot, of course, be caused to look into the instrument. In this case both eyes fixate the distant chart whenever possible. This was possible only from 25 to 60 degrees. That is, for the range 0 to 25 degrees, when the temporal field was being refracted, the instrument was interposed between the test chart and the eye under examination. The fixation then had to be maintained by the other eye alone. For the range 0 to 25 degrees, when the nasal field was being refracted, the instrument was interposed between both eyes and the test chart. In this case the effect of distance was given to the eye not under examination by mounting close in front of it a small test letter placed at or beyond the principal focus of a double convex lens, thus causing the rays of light from the lens to enter the eye parallel, diverging or converging as desired. Coordination of fixation for the zero position of the instrument was secured by locating the object and the bright spot in the instrument in such relation that the test objects presented to the two eyes were seen as combined in the median plane. When a cycloplegic was used, the procedure was the same, with the exception that the fixating eye was not fogged.

With the eyes in position and the fixation held as described, the refraction of the eye was read at the center and in the nasal and temporal quadrants of the horizontal meridian at intervals of 5 or 10 degrees out to 60 degrees. At each angle of incidence tested, the refraction for both the horizontal and the vertical meridians was recorded, i. e., the refraction in the plane of the incidence of the light and in the plane at right angles to it. The error of reading was approximately 0.25 diopter in the central field and the midperiphery, and approximately 0.37 to 0.5 diopter in the far periphery where the reflected images, owing to the high degrees of astigmatism present, were indistinct.

RESULTS

A consideration of the effect of obliqueness of incidence on the refracting powers of a lens would lead one to expect myopia in the meridian corresponding to the plane of incidence in an emmetropic eye with its refracting system symmetrically disposed in relation to the line of sight; that is, the effect of the oblique incidence in this plane is that of a strong positive cylinder. What the condition would be in the meridian at right angles to the plane of incidence would depend on two factors: (*a*) the effect of the obliqueness of incidence on the focus in this meridian, which, as already stated, is equivalent to that of the addition of a weak positive sphere, and (*b*) the shape of the eyeball. In proportion as the eye is spherical in shape, the retina from center to periphery is brought closer to the nodal point of the refracting system. In an emmetropic eye, therefore, with a symmetrical refracting

system, one would expect a condition of hyperopia in this meridian, beginning at a point comparatively near the center of the field. At some point in the periphery in this type of eye a condition of mixed astigmatism might be expected. A mixed astigmatism might be expected also in case of small refractive errors at the center—hyperopic or myopic. In case of a sufficient amount of myopia at the center, a condition of compound myopia might be found in the periphery, and similarly a condition of compound hyperopia in the periphery when a strong hyperopia is present in the central field. Obviously it is also possible

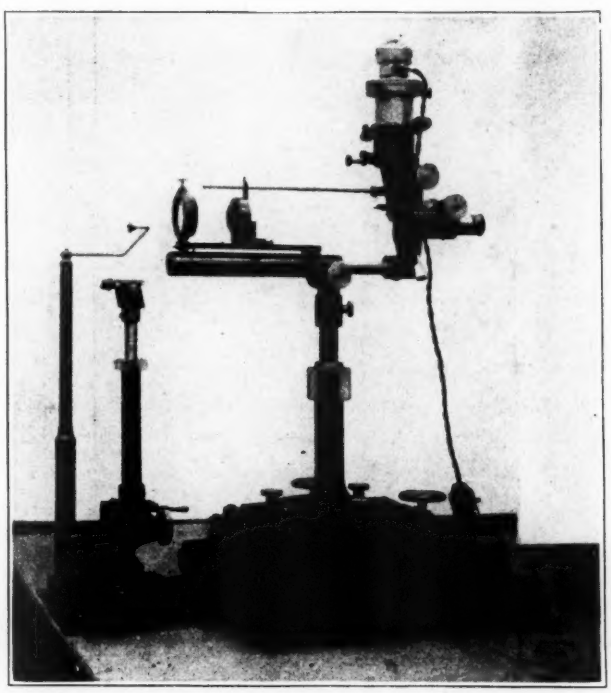

Fig. 1.—Modified Zeiss parallax refractometer.

that even with small central errors of refraction, the shape of the curve of the eyeball from the posterior pole toward the equator may be such as to cause either a compound myopia or a compound hyperopia even when there is only a slight error of refraction at the center. In this connection it should be remembered that in case of such a strong refractive system as is found in the eye, a very small difference in the distance of the retina from the nodal point is sufficient to cause a difference of several diopters in myopia or hyperopia.

Twenty-one eyes were examined, fifteen without and six with a cycloplegic. The amount of refractive error at the center varied from 0.25 diopter of astigmatism to several diopters of defect. Classified

as to peripheral refraction in general, three types were found. In one type (*A*) the eye becomes more myopic in the horizontal meridian as the periphery of the field is approached, and more hyperopic in the vertical meridian; that is, the curve for the horizontal meridian tends downward as the periphery is approached and the curve for the vertical meridian tends upward. In all the cases but one in which there was a high myopic astigmatism this resulted in a mixed astigmatism in the peripheral field, the interval of Sturm varying over a considerable range of diopters. In a second type (*B*) the eye becomes less myopic in the horizontal meridian as the periphery of the field is approached, and more hyperopic in the vertical meridian; that is, the trend of the curves for both meridians is upward. In the cases studied this resulted in compound hyperopia in the peripheral field for eyes that were hyperopic, emmetropic or moderately myopic in the central field. If strong myopia is present at the center, it is obviously possible that compound myopia might result over a greater part of the peripheral field. In a third type (*C*) the condition was asymmetrical; i. e., a considerable difference was found in the nasal and temporal meridional quadrants. The description of these cases, however, will be reserved for a future paper.

The results are shown in figures 2, 3 and 4. In these charts the results for the horizontal meridian, the meridian of the plane of incidence of the light, are plotted as a solid line; those for the vertical meridian, the meridian at right angles to the plane of incidence of the light, as a broken line. Degrees of eccentricity are plotted along the horizontal coordinate and diopters of refractive defect along the vertical coordinate. The condition of no refractive defect is represented by a horizontal line drawn through the center of the chart. Diopters of hyperopia are plotted above this line along the vertical coordinate; diopters of myopia below it. The diopters of hyperopia and myopia are expressed in terms of the correction needed, + and —, respectively. The value of the interval of Sturm can be read along the vertical coordinate at corresponding points between the solid and broken lines.

In figure 2 are shown the results for six eyes of the class that we have called type *A*. These eyes all had only a slight refractive error at the center. It will be noted that in general the defect in the vertical meridian, the amount of which is shown by the displacement of the broken line from the line of reference or zero line, is much smaller than the defect in the horizontal meridian, shown by the displacement of the solid line. That is, the defect that is due to the obliqueness of incidence of the light on the refractive system is greater than the defect that is due to the progressive approach of the retina to the nodal point as the distance of the point under examination from the center

of the field becomes greater. In short, in most cases much the greater part of the interval of Sturm is due to the astigmatism of oblique incidence. Some asymmetry will be noticed also in case 6 of this chart, but not enough to warrant placing this case in the class that we have called type *C*.

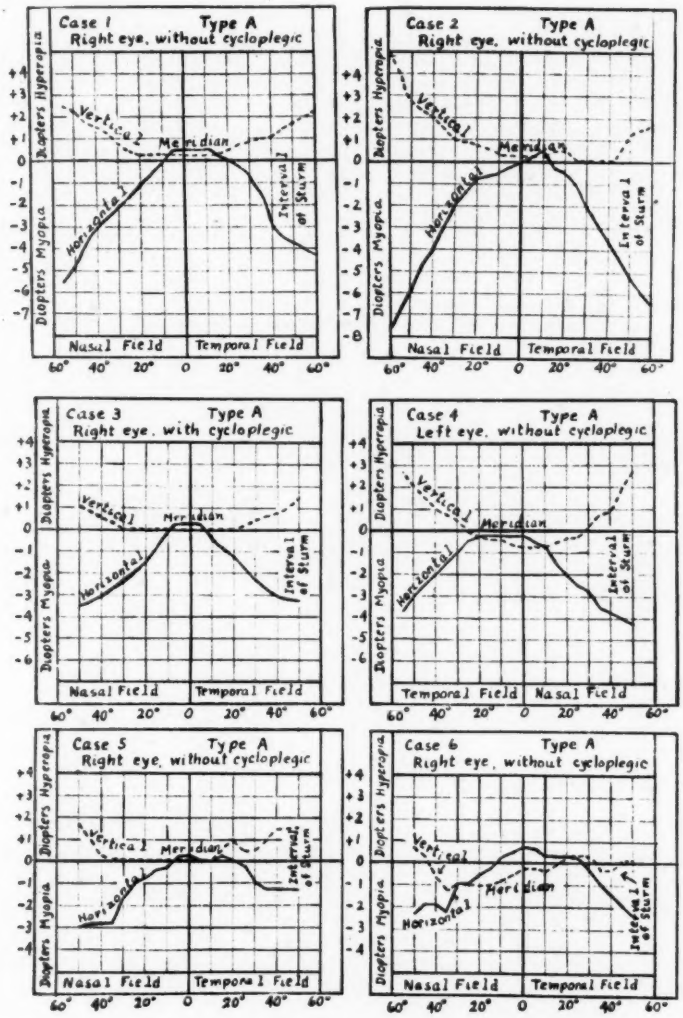

Fig. 2.—The refraction of the peripheral field of vision for six eyes of the class called type *A*. These eyes have only a slight refractive error at the center.

In figure 3 are shown the results for six eyes also of the class that we have called type *A*. These eyes had a much more pronounced error of refraction at the center. The following points may be noted in connection with the results for this chart: (*a*) The curves are less regular. (*b*) The temporal and nasal halves of the curves are less symmetrical.

Case 8 shows so much asymmetry as to deserve, perhaps, to be classed as type *C*. (*c*) The point at which the mixed astigmatism begins is farther from the center of the field than is the case in figure 2; that is, a smaller proportion of the field carries a mixed astigmatism and a greater proportion a compound myopic or a compound hyperopic astig-

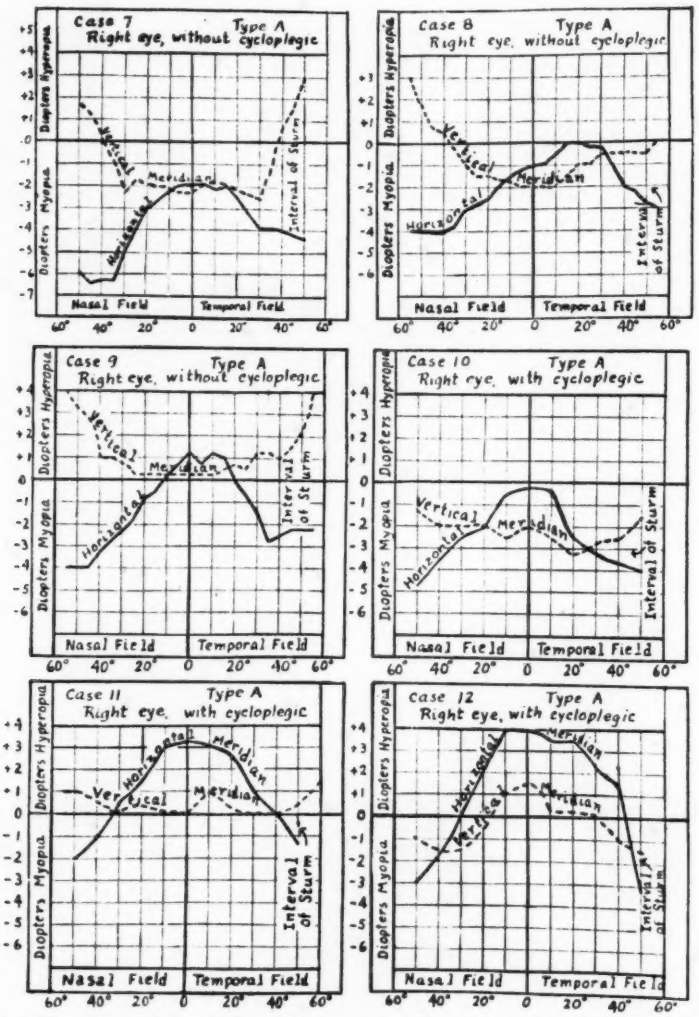

Fig. 3.—The refraction of the peripheral field of vision for six eyes of the class called type *A*. These eyes have a pronounced error of refraction at the center.

matism. In case 10, in which there was a high compound myopic astigmatism with the greater myopia in the vertical meridian, the curves for the two meridians cross at approximately 20 to 25 degrees from the center of the field; i. e., beyond these points the eye becomes more myopic in the horizontal meridian and less myopic in the vertical meri-

dian, but it retains a compound myopia as far out as the examination was made. The astigmatism changed, however, from compound myopia with the rule to compound myopia against the rule.

In figure 4 are shown the results for six eyes which belong to the class that we have called type *B*. The characteristic defects in the

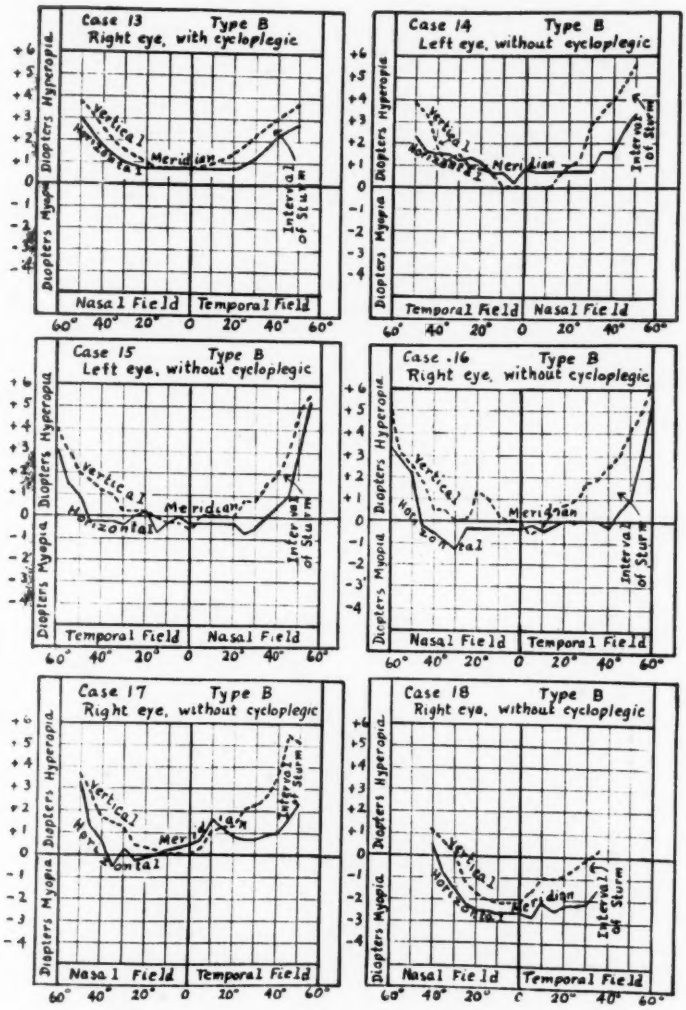

Fig. 4.—The refraction of the peripheral field of vision for six eyes of the class called type *B*. Five of these eyes have only a slight refractive error at the center; one a more pronounced error.

peripheral field for these eyes were compound hyperopia and compound myopia. Four of the eyes had a slight refractive error at the center of the field and two a more pronounced error. As shown in the chart, a striking feature of these cases is the smallness of the interval of

Sturm in the peripheral field. In type *A* the general trend of the curve for the vertical meridian from the center toward the periphery is upward and that of the curve for the horizontal meridian downward. This gives a progressively increasing value to the interval of Sturm from the center toward the periphery. In the cases of type *B*, however, the trend of both curves from the center toward the periphery is upward, the trend for the curve for the horizontal meridian being less sharply upward. There is thus an interval of Sturm, but it is of smaller value than for the cases of type *A*. It would appear that the astigmatism of incidence does not play proportionately so strong a rôle in the eyes of type *B* as it does in the eyes of type *A*.

In figure 5*a* are given curves showing the average of the results in the two meridional quadrants for the six cases of the class that we

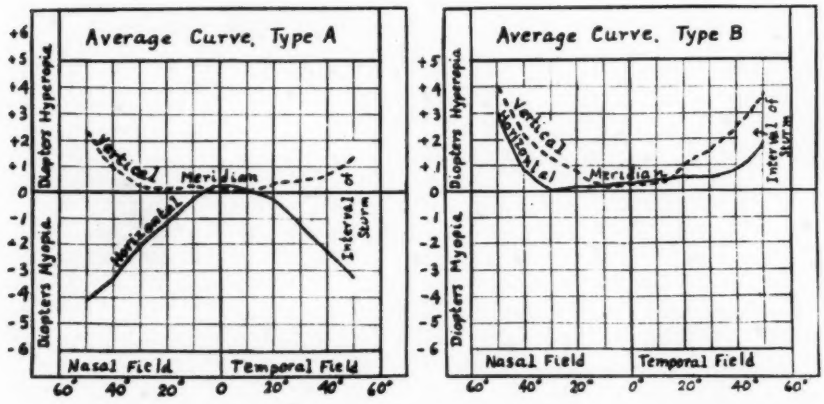

Fig. 5.—The chart at the left shows the average refraction of the peripheral field of vision for the six eyes having only a slight error of refraction at the center, type *A;* that at the right, the average refraction of the peripheral field of vision for the five eyes having only a slight error of refraction at the center, type *B*.

have called type *A*. We have selected for this average only the cases that showed a slight defect in refraction in the central field. This chart shows a slight asymmetry; i. e., in the nasal half of the field there is a greater amount of myopia in the horizontal meridian and a greater amount of hyperopia in the vertical meridian than there is in the temporal half of the field. In figure 5*b* are given average curves for the two meridional quadrants for five of the cases that we have called type *B*. We have selected for the average curve here, also, only the cases that showed a slight defect of refraction in the central field. The average curves for the two meridional quadrants show less asymmetry, perhaps, than the curves in figure 5*a*. Here too a greater refractive defect is shown in the nasal than in the temporal field. In tables 1 and 2 are given the values used in compiling these average curves.

A phenomenon of great theoretical and practical interest observed during the course of the work may be noted here. During the early part of the work, the examination at the different points in the peripheral

TABLE 1.—*Refraction at Various Points in the Peripheral Field of Vision for the Six Eyes of Type A Having Only a Slight Error of Refraction at the Center* *

		Temporal Field						Nasal Field				
Meridian	Case	0 Degrees	10 Degrees	20 Degrees	30 Degrees	40 Degrees	50 Degrees	10 Degrees	20 Degrees	30 Degrees	40 Degrees	50 Degrees
Horizontal	1	+0.50	+0.50	0.00	−0.75	−3.00	−3.75	0.00	−1.00	−2.00	−3.00	−4.75
	2	0.00	+0.50	−0.50	−2.00	−3.50	−5.25	−0.37	−0.75	−2.00	−4.00	−6.00
	3	+0.25	−0.50	−1.25	−2.25	−3.00	−3.25	0.00	−1.50	−2.25	−4.00	−4.50
	4	−0.25	−0.25	−0.25	−1.00	−2.00	−3.00	−0.75	−2.00	−2.75	−3.75	−4.25
	5	+0.25	0.00	−0.25	−1.25	−1.25	−1.25	−0.25	−0.75	−1.75	−2.75	−3.00
	6	+0.75	+0.37	+0.37	−0.37	−1.37	−2.37	+0.25	−0.50	−0.37	−1.87	−2.12
Average		+0.25	+0.10	−0.31	−1.27	−2.35	−3.14	−0.19	−1.08	−1.94	−3.23	−4.10
Vertical	1	+0.25	+0.25	+0.50	+0.87	+1.12	+1.75	+0.25	+0.25	+0.75	+1.50	+2.25
	2	+0.25	+0.25	+0.50	0.00	0.00	+1.25	+0.50	+0.75	+1.00	+2.00	+2.75
	3	0.00	0.00	0.00	+0.50	+0.75	+1.50	0.00	0.00	0.00	+0.50	+1.00
	4	−0.75	−0.37	−0.25	+0.50	+1.00	+2.00	−0.75	−0.37	+0.25	+1.00	+2.75
	5	0.00	0.00	+1.00	+0.50	+1.50	+1.50	0.00	0.00	0.00	+0.25	+1.75
	6	−0.25	−0.37	+0.37	+0.12	−0.37	+0.12	−0.75	−1.00	−0.87	−0.62	+0.62
Average		−0.08	−0.04	+0.35	+0.42	+0.67	+1.35	−0.13	−0.06	+0.19	+0.94	+2.31

* These values were used in computing the average curve for type A.

TABLE 2.—*Refraction at Various Points in the Peripheral Field of Vision for the Five Eyes of Type B Having Only a Slight Error of Refraction at the Center* *

		Temporal Field						Nasal Field				
Meridian	Case	0 Degrees	10 Degrees	20 Degrees	30 Degrees	40 Degrees	50 Degrees	10 Degrees	20 Degrees	30 Degrees	40 Degrees	50 Degrees
Horizontal	13	+0.75	+0.75	+0.75	+1.25	+2.25	+2.75	+0.75	+0.75	+1.00	+1.75	+3.00
	14	+0.87	+0.62	+1.12	+1.25	+1.50	+2.37	+0.75	+0.75	+0.75	+1.62	+3.50
	15	−0.25	−0.25	+0.25	−0.37	−0.25	+0.87	−0.25	−0.25	−0.50	+0.50	+3.00
	16	−0.37	−0.50	0.00	0.00	−0.25	+1.00	−0.37	−0.37	−1.25	−0.50	+2.25
	17	+0.50	+1.62	+0.87	+0.75	+1.00	+2.37	+0.25	−0.12	+0.25	+0.62	+3.25
Average		+0.30	+0.44	+0.60	+0.57	+0.85	+1.87	+0.23	+0.15	+0.05	+0.80	+3.00
Vertical	13	+0.75	+1.00	+1.50	+2.25	+3.00	+3.50	+0.75	+1.00	+1.50	+2.50	+3.75
	14	0.00	0.00	+0.87	+1.37	+1.87	+3.87	0.00	+1.00	+2.87	+4.00	+5.50
	15	−0.50	−0.25	+0.25	+0.25	+1.25	+2.00	0.00	0.00	+0.75	+2.00	+4.75
	16	0.00	−0.25	+0.75	+1.75	+2.50	+4.12	+0.25	+1.37	0.00	+0.50	+2.50
	17	0.00	+1.12	+1.37	+2.25	+3.62	+5.12	0.00	+0.37	+1.25	+1.75	+3.62
Average		+0.25	+0.32	+0.95	+1.57	+2.45	+3.72	+0.20	+0.75	+1.27	+2.15	+4.02

* These values were used in computing the average curve for type B.

field was made by taking an eccentric fixation, the instrument remaining stationary. One of the reasons for abandoning this procedure was the fact that in type *A*, when the fixation was held for any appreciable length of time, an increased myopia developed in the horizontal meridian with a corresponding decrease in the hyperopia for the vertical meridian. With prolonged fixation this change in some cases amounted to as much

as 2.5 diopters. A similar tendency in the same direction was shown also in type *B*. Further, when the method was changed and a far fixation was taken in the median plane—the examination at the peripheral points in the field being made by rotating the apparatus about the fixed point mentioned in the description of the method—the phenomenon was still present in some eyes but to a lesser degree. There seem to be two possible explanations of the phenomenon: (*a*) a change in the convexity of the lens, and (*b*) the possibility that as the fixation is prolonged the muscles of the eye gradually produce an elongation of the eyeball.[4] The first of these explanations does not seem plausible, because rendering the eye myopic by a change in the focus of the lens would operate against clear vision of the fixation object. This would be in opposition to one of the eye's strongest reflex incentives, namely, the adjustment of its refracting mechanism to produce the clearest possible vision; while the gradual elongation of the eyeball, because of the pressure exerted by the external muscles in maintaining fixation, falls entirely outside the reflex and is unavoidable.

To test this point, the examination was made under as profound a cycloplegia as could be obtained with atropine. The performance of the Zeiss refractometer is not as satisfactory with as without a cycloplegic. With wide expansion of the pupil, produced by the cycloplegic, the test images that are formed by the refracting system of the eye are not nearly so clear and distinct as they are with smaller pupils. This affords another interesting example of the poor and unnatural performance of the refraction system of the eye with an expanded pupil. It was found possible, however, to make the examination under a cycloplegic with a fair degree of satisfaction. The phenomenon was still present, but in a diminished amount.

In connection with the phenomenon two points of interest may be noted: (*a*) There is a possibility of a permanent elongation of the eyeball by the pressure of the external muscles or the production of myopia, and (*b*) the phenomenon strongly suggests that a temporary elongation may be produced in some eyes, presumably due to the action of the external muscles. This is of interest in connection with theories of accommodation and with the ability of certain aphacic eyes to see near objects with the same correction that is used for seeing distant objects.

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4. It is assumed here that the eyes are under considerable pressure from the external muscles in a prolonged eccentric fixation, the amount depending on the degree of eccentricity. It is also assumed that they are under some pressure in taking and holding far fixation in the median plane; that is, when relaxed and freed from all incentives to adjustment for clear sight, as with closed lids and in the dark, the eyes take a more converging position.

SUMMARY AND CONCLUSIONS

1. The refraction of the eye in the temporal and nasal peripheral field as far out as 60 degrees was studied by means of a Zeiss refractometer modified to suit the purpose. Twenty-one eyes were examined. Those selected included eyes with a slight central error of refraction and eyes with a pronounced central error of refraction.

2. The eyes examined fell into three classes: In type *A*, the eye becomes more myopic in the horizontal meridian as the periphery of the field is approached and more hyperopic in the vertical meridian. In all eyes examined but one (in which there was a high myopic astigmatism in the central field), this resulted in a mixed astigmatism in the peripheral field, the interval of Sturm varying over a considerable range of diopters. In type *B*, the eye becomes less myopic in the horizontal meridian and more hyperopic in the vertical meridian. This results in a condition of compound hyperopic astigmatism in the peripheral field for eyes that are hyperopic, emmetropic and moderately myopic in the central field. If there is strong myopia at the center of the field, it is obviously possible that a compound myopic astigmatism might result over the greater part of the peripheral field, weakening in amount as the periphery is approached. In type *C*, the refractive condition is asymmetrical for the nasal and temporal halves of the field. The general trend of this asymmetry, as the periphery of the field is approached, is greater myopia and less hyperopia for one half of the field than for the other half.

3. As fixation was prolonged, a tendency toward myopia was found; that is, if hyperopic, the eye tended to become less hyperopic; if emmetropic, it tended to become myopic, and if myopic, more myopic. This change was found to take place in all the eyes examined when an eccentric fixation was taken; also for some eyes when a far fixation was taken in the median plane. Further, the change was found to take place whether the examination was made with or without a cycloplegic. Two points of interest may be noted in connection with this phenomenon: (*a*) There is a possibility of a permanent elongation of the eyeball by the pressure of the muscles or the production of myopia, and (*b*) the phenomenon suggests that a temporary elongation may be produced in some eyes, presumably due to the action of the external muscles. This is of interest in connection with theories of accommodation and with the ability of some aphacic eyes to see near objects with the same correction that is used for seeing distant objects.

ELECTROCOAGULATION OF PTERYGIA*

MATTHEW F. C. ZUBAK, M.D.
WHEELING, W. VA.

As I had used electrocoagulation for three years and realized its usefulness in the removal of minute growths, such as warts, moles, milia, cysts, etc., its possibilities in the destruction of pterygia appealed to me. In the first case it required no small amount of daring, not only in the patient, to whom the situation was explained, but probably even more in myself. Nothing unfavorable resulted, however, and the success of the initial venture caused me to adopt it in all cases for the past two years.

The machine used is that regularly sold for electrocoagulation, fulguration and surgical diathermy, with the means available for changing from one type of current to the other. One switch is marked "strong-weak." The switch is set at "strong" and the voltage, and spark gap settings are adjusted so that on short-circuiting the coagulation current, the milliamperemeter reading is 2,000. Then the switch is changed from "strong" to "weak." This procedure is followed because if one first switches to the "weak" current, the short circuit test will yield no reading on the milliamperemeter, the weak currents not being connected to the meter.

Butyn anesthesia is used, 2 drops of a 2 per cent solution being instilled three times at three minute intervals. With the fixation forceps the pterygium is grasped at its broadest expanse and raised from the globe. An ordinary sewing needle bent at right angles, with the short arm 2 mm. long, is hooked into the neck of the pterygium about half way between the forceps and the corneal limbus. The foot switch is activated for but a fraction of a second to test out the apparatus and to check up on the amount of coagulation accomplished. This is visible to the naked eye in a distinct blanching extending along the long axis of the pterygium.

My usual procedure then is to insert the needle just sufficiently to coagulate the inferior margin of the pterygium. The superior margin, and lastly the midportion, are similarly coagulated. The neck and head of the growth now turn a distinct white. The amount of coagulation in the body of the pterygium is unimportant at the first visit. A drop of homatropine hydrobromide is instilled, and phenacaine is ordered for use at home whenever required. The eye need be occluded only in the exceptional case in which a nervous temperament prevails. The reaction is moderate.

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At the second visit, one week later, the head and neck, as well as part of the body of the growth, will have sloughed off. The remainder is now coagulated with a little more daring, as it is distant from the cornea. It will be noted that if there is one living strand of tissue extending to the limbus, the coagulation seems to run along this strand rapidly, so that these remnants must be severed with the needle before the fleshy body is attacked with added vigor.

Seven pterygia have been removed to date in this manner. The earliest of these cases, in which the operation was performed two years before this writing, was inspected recently. There had been no recurrence and no complaint.

This method makes the removal of a pterygium an office procedure, devoid of pain, requiring no preparation or loss of time and, from the point of view of the patient, economically desirable. Should the growth recur, no apologies are required nor does the patient need to fear the loss of time as in an operative measure. Infection is automatically precluded by the sterilizing qualities of the electric current.

In the hands of one accustomed to the use of diathermic currents, it offers a safer, more rapid and more economical method for the removal and destruction of pterygia than do surgical measures.

BINOCULAR VISION AND PROJECTION*

ALEXANDER DUANE, M.D.†
NEW YORK

BINOCULAR VISION

Binocular Single Vision; Fusion.—In all but a small minority of cases binocular fixation is present whenever one looks with both eyes. The image of the object looked at, then, is formed on each fovea (fig. 1).

Yet, though there are two images, one sees, not two objects, but one object (binocular single vision). For the mind by a peculiar process which we denominate fusion combines the two retinal images into a single visual impression, which differs notably from the impression derived from each eye when seeing separately.

Fusion of Images Formed on Corresponding Points.—Not only does the mind fuse the two retinal images of any object looked at directly, but it also fuses the images of a number of objects seen by indirect vision. Fusion, in fact, occurs for any object, the retinal images of which fall on corresponding points, i. e., on the two points that are equally far and have the same direction from the fovea in each eye. Thus an object that forms its retinal image 10 degrees to the right of and 5 degrees above the fovea in each eye will appear single.

How Fusion Is Effected.—How the sensory impressions received from the two foveas or any other pair of corresponding points are fused into a single sensory impression is not known. It does seem established that the neuron in the occipital cortex with which each member of such a pair is connected is close to the neuron that is connected with its fellow, and that the two neurons thus constituting the cerebral representatives of each pair of corresponding points habitually work together to produce a common mental impression. Whether they do this by communicating with each other or by both communicating with a common center (fusion center) is undetermined.

Horopter.—A priori, it would seem that there should be a great many objects in space that would form their images on corresponding points and would therefore appear single. It seems, however, that there are comparatively few objects in the binocular field of vision of which this is true. Objects that do thus appear single when the eyes are fixing some other object occupy a limited portion of space called the heropter.

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† Dr. Alexander Duane died on June 10, 1926.

Müller supposed the horopter to be a circle passing through the object of fixation *A* and the nodal points of the two eyes *R* and *L* (fig. 1). This idea seems justified *a priori*, since the angles *ALD* and *ARD* are equal, and consequently *s* has the same angular distance from *m* that *t* has from *n;* i. e., *s* and *t* are corresponding points. But this deduction is based on the assumption that the eyes undergo no torsion when converging on *A*, so that their vertical meridians remain parallel. As a matter of fact, the eyes do undergo torsion in convergence so that the two points on which the retinal images of one object fall and which would be correspondent in the two eyes if the vertical meridians had remained vertical no longer correspond. Various authors have studied the effect of this torsion on corresponding points and consequently on the horopter. LeConte, who is in substantial agreement with Meissner, believes that the facts are as follows:

When the eyes are converged on an object *A* in the horizontal plane, the horopter is a straight line passing through *A*. This line is not quite perpendicular to the visual plane (i. e., the plane passing through the two visual lines). It tips backward (with its upper end away from the observer), by an angle of 7 or 8

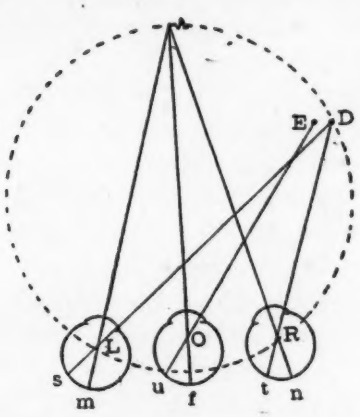

Fig. 1.—Binocular single vision: The two eyes are fixing the same object, *A*. This forms its images *m* and *n* on the foveae of the two eyes, and hence appears single. It is exactly as if the two eyes had been combined in the midline to form one eye or binoculus, *O*, on the fovea of which *f*, representing the combined foveae *m* and *n*, the image of *A* had fallen (see fig. 2). Another object that formed its image on corresponding points *s* and *t* of the two retinas—i. e., on points such that *s* has the same angular distance from *m* that *t* has from *n*—would also appear single. According to Müller's hypothesis, an object such as *D* lying in the circle (dotted line) which passes through *A* and the nodal points *L* and *R* of the left and right eyes would form images in this way and would hence appear single. The circle *ALR* would therefore be a horopter. But, as stated in the text, *D* does not in general form its image on *s* and *t*, and the horopter has a different shape.

degrees. This angle increases in looking up, and decreases in looking down. When the eyes are directed 45 degrees down, the horopteric line becomes perpendicular to the visual plane and expands into a surface, which Meissner regards as a plane, but LeConte as curved.

LeConte believes that this restriction of the horopter to a single line subserves a useful purpose since it focuses the observer's attention definitely on the object of fixation, by making other objects appear double and less distinct. In fact, the horopter effects for both eyes very much what the fovea effects for one. To quote

LeConte's suggestive words: "A general view of objects in a wide field is a necessary condition of universal life in its higher phases; but an equal distinctness of all objects in this field would be fatal to the thoughtful attention which is necessary to the development of the higher faculties of the human mind. Therefore the human eye is so constructed and moved as to restrict as much as possible the conditions both of distinct vision and of single vision. Thus, as in monocular vision the more elaborate structure of the central spot restricts distinct vision to the visual line, and focal adjustment still further restricts it to a single point in that line, the point of sight, so also in binocular vision axial adjustment restricts single vision to the horopter, while rotation on the optic axes restricts the horopter to a single line."

It must be said that it is by no means certain that the torsion of the eyes in convergence is alike in every case. Consequently, one cannot be sure that the horopter has the same form in all persons. Finally, it must be said that if one accepts LeConte's observations the tilting of the vertical meridian is inconsiderable, unless the eyes are strongly converged (to a point within 8 or 9 inches (20.32 or 22.86 cm.) of the nose. Accordingly, it would seem that for all ordinary ranges of vision this element could not affect the horopter and that the latter might well have the form described by Müller.

Fusion of Dissimilar Objects; Stereopsis.—When the two eyes are fixing an object, the two images of any object falling on a pair of corresponding points are rarely alike. This applies especially to the two foveal images. For when one is looking at any object that is not perfectly flat, one eye sees a portion of the object differing somewhat from that seen by the other. Each fovea thus receives a somewhat different impression. This pair of differing impressions is converted into a single visual concept which combines the characters of the two. At the same time there is afforded a sense of solidity and depth (stereopsis) which is lacking in the monocular picture. The stereoscopic effect, which is produced naturally when one looks at a solid object with both eyes, can be imitated artificially by the combination, e. g., in a stereoscope, of two pictures of the same object, which pictures are flat but taken from a somewhat different point of view. In the one case the two cameras, and in the other case the two eyes, sighting the same object from different positions, record two slightly dissimilar impressions. And just as the eyes fuse the two dissimilar foveal impressions into one, so they fuse the two dissimilar stereoscopic pictures and get in the latter case, as in the former, a sense of depth and relief. Moreover, if they fail in the one case they also fail in the other. That is, a person who lacks the ability to fuse the two foveal images of a natural object into an image possessing relief and depth will in general also fail to get this effect with the stereoscope.

The elements effecting stereopsis will be discussed later; it suffices to say here that the ability to secure stereopsis varies a good deal in different people. In some people it is absent or imperfect, in others it is moderately developed, and in still others highly developed. In those

in whom it is weak, it can often be improved by practice; such practice serves as an incentive to the development and maintenance of binocular fixation. Hence, when there is a disorder of binocular fixation causing a deviation of the eyes, practice of fusion with the stereoscope or in other ways not only relieves the defective stereopsis that accompanies the deviation, but tends to relieve the latter itself.

The dissimilarity of the two images thrown on the foveae or other pair of corresponding points must not be too great. If it is, and also if one image, though like the other, is much less distinct, the mind instead of uniting the two images tends to suppress one of them, so that the conditions of a purely monocular vision obtain. When this is the case, one may restore stereopsis by any device equalizing the distinctness of the two images. Thus, if in using the amblyoscope the image in the left eye is suppressed, one may regain fusion by reducing the distinctness of the image in the right eye.

BINOCULAR PROJECTION

Binocular Projection.—Just as in the case of monocular visual impressions, only more accurately and with greater certainty, the visual impression produced by fusion of the two retinal images of the object of fixation is mentally projected or referred to a definite portion of space outside of the body. The point to which one thus refers the impression is the point of intersection of one's two visual lines. Thus, when one looks at an object, *A* (fig. 2), their visual lines *LA* and *RA* are both directed at the object, and hence intersect at the point where it is situated. Then each foveal image is projected out to this point of intersection, i. e., to the place the object itself actually occupies.

The Binoculus.—In binocular projection, as in monocular projection, there are both visual and postural elements. The visual element helps one localize an object through the impression that its retinal image produces. In this respect, binocular is like monocular projection, with the important difference, to which I have already referred, that in the former there are two simultaneous and usually not quite identical retinal images of the same object, which reinforce each other so as to increase materially the clearness of the impression and to add to it a sensation of depth.

With regard to the postural element in binocular projection, there are two factors to be considered: 1. As in monocular projection, in binocular projection there are the sensations derived from the movements of the head and from the conjugate movements of the eyes which make one aware that the latter are directed right, left, up or down, and which thus tell one how objects are situated in a transverse plane. 2. Sensations are derived from movements of convergence. These sen-

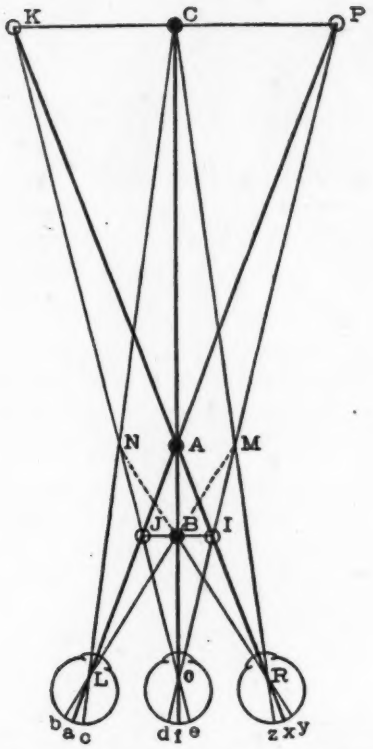

Fig. 2.—Projection from the binoculus; bifoveal single vision and physiologic diplopia. *L* and *R* are nodal points of the left and the right eye. *A* is the object of binocular fixation, forming its image on *a* and *x*, the foveae of the right and the left eyes. *B* is an object nearer than *A*, forming its image on the retinal points *b* and *y*. *C* is an object more remote than *A*, forming its image on the points *c* and *z*. *LA* and *RA* are visual lines of the left eye and the right eye, converging on *A*. *O* is the nodal point of the binoculus (binodal point) representing the fusion of *L* and *R*. *f* is the fovea of the binoculus (bifovea), representing the fusion of *a* and *x*. *d* is a point in the retina of the binoculus representing the fusion of the corresponding points *b* and *z*. *e* is a point representing the fusion of the corresponding points *c* and *y*. *OA* is the bivisual line, representing the fusion of *LA* and *RA*. *M* and *N* locates the physiologic double images of *B* and *C* according to the common explanation. *I* and *J* indicate the true location of the physiologic (crossed) double images of *B*. *K* and *P* mark the true location of the physiologic (homonymous) double images of C.

The five intrinsic methods of estimating distance are: Methods, either monocular or binocular: 1. Size of the retinal image (mathematical perspective). *B*, imagined to be of the same size as *A*, is judged to be nearer than *A* because its retinal image is larger; and *C* is judged to be further than *A* because its retinal image is smaller (visual projection). 2. Differences in accommodative effort. *B* is judged to be nearer than *A*, because it requires more effort to accommodate on it. For a like reason, *A* is judged to be nearer than *C* (postural projection). Methods obtaining in binocular vision only: 3. Dissimilarity in the retinal images of the object fixed. *L* sees the front and left side of *A; R*, the front and right side of it. The two eyes thus receive retinal images that are somewhat dissimilar, and the fusion of these images produces an impression of solidity and depth (visual projection). 4. Differences in converging effort. *B* is judged to be nearer than *A* because it costs more effort to converge on it. For a like reason, *A* is judged to be nearer than *C* (postural projection). 5. Physiologic double images. *A* appears single because its image falls on the fovea (*a*, *x*) in each eye; *B* appears in the crossed double images *I* and *J*, and *C* appears in the homonymous double images *K* and *P*, because their images fall on noncorrespondent points. The impression received (see text) implies that *B* is nearer and *C* farther than *A*. The projection here is a complex of postural and visual factors. (This figure, but not the description, is modeled in part after LeConte.)

sations are the distinguishing feature of binocular projection, differentiating it from monocular projection and serving to explain all of the phenomena of binocular diplopia. Hence, this factor requires careful consideration, which can perhaps be had best by reference to figure 2.

Suppose the eyes *L* and *R* are turned in by an equal converging effort to sight the object *A*. The left eye, *L*, made aware of its inward turning by the muscle sense, would if acting by itself receive the impression that *A* is situated on the right and, in fact, somewhere along the line *LA*. Similarly, the right eye, *R*, acting by itself would receive the impression that *A* is on the left and indeed somewhere along the line *RA*. But if binocular were conducted like monocular projection, neither impression would tell where on *LA* and *RA* *A* is. For when the left eye by the conjugate (eyes-right) movement employed in monocular vision turns toward *A*, the muscular effort involved is the same no matter where *A* is situated along the line *LA*. But when both eyes turn together toward *A*, the position is reached, not by a conjugate movement, but by an effort of convergence, which is precisely equal in the two eyes. The result is that the mind receives the simultaneous impression that *A* is as much to the right of *L* as it is to the left of *R*; in other words, that it is in the midline *OAC*. Moreover, since the converging effort increases pari passu with the angle of convergence, the sensation conveyed is that *A* is nearer than an object *C* on which one would have to converge less and farther than an object *B* on which one would have to converge more. Furthermore, *A* appears single because the similar, but usually not quite identical, images formed on the foveae *a* and *x* of *L* and *R* are combined by the process called fusion into a single, composite image affording more or less the impression of depth and relief.

The net result of the two distinctive factors of binocular projection, viz., fusion, or the visual element, and convergence, or the postural element, is that *A* or any other point that is the object of bifoveal fixation (*a*) is considered always to lie in the midline *OAC*; (*b*) is regarded as at a more or less definite point on that line, and, in fact, in about its true place, and (*c*) appears single.

The same is true if *A* while forming its image on the fovea in each eye is not situated straight ahead but to one side, say the right. The only difference is that to the equal converging effort which each eye is making and which tells one that *A* is in the midline between the eyes is added a conjugate movement which tells one that inasmuch as both eyes while fixing *A* are swung to the right *A* itself is also situated on the right.

One may, in fact, conceive binocular projection, as performed by a single cyclopean eye, or, to use Maddox's useful phrase, a binoculus

(*O*) situated in the midline, with its visual line directed along *OAC*. The fovea of this eye (*f*), representing the combined foveae *a* and *x*, may be called the bifovea; *O*, representing the combined nodal points *L* and *R*, may be called the binodal point, and the visual line *OAC*, representing the fusion of the two visual lines *LA* and *RA*, may be called the bivisual line. The bivisual line may be directed straight ahead, sideways or up and down, but its direction is always given by a line connecting the binodal point, *O*, with the object of fixation, *A*.

Projection by the Binoculus; Explanation of Binocular Single Vision.—Projection by the binoculus is performed just as it would be by each eye, if each were transferred to the root of the nose and then rotated, the left eye to the left and the right eye to the right until the fovea of each was in the midline (*a* and *x* transferred to *f*, and *LA* and *RA* made to coincide with *OA*). Any object the image of which falls simultaneously on the foveae, *a* and *x*, or as one might say, on the bifovea, *f*, is projected along *OA*.

The binoculus may be regarded as a concept by which one can best denote the result of the fusion of binocular visual impressions in the cerebral cortex and the way in which these fused impressions are reprojected out into the external world. It represents not only the fusion of the right and left foveae and of the right and left visual lines, but the fusion of each pair of corresponding points in the two eyes. Thus not only does *f* represent the fusion of *a* and *x*, but *d* represents the fusion of *b* and *z*, and *e* the fusion of *c* and *v*. As the points *b* and *z* are linked together by their connections in the left cerebral cortex, ordinarily they convey a sense of identity of position, and hence, if stimulated simultaneously, project their respective images to the same point in space. It is exactly as if instead of projection being made from the two points *s* and *t* of the left and right eye, respectively, (fig. 1), it were made from the point *u* bearing the same relation [1] to the bifovea *f* that *s* does to *m* and *t* does to *n*. In this case *u* is the peripheral representative of the cortical impression produced by the fusion of the two sensory impressions sent up from *s* and *t*.

With the binoculus one thus gains binocular single vision and also the correct placing of external objects, when the latter form images simultaneously in the two foveae or simultaneously on any pair of corresponding points.

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1. If *u* bears exactly the same relation to *f* that *s* does to *m* and *t* to *n* and if projection is made from *u* strictly on the basis of sensory perceptions, then the combined visual impressions set up by a body *D* would be reprojected, not to *D*, but to *E* a little nearer the midline. Apparently, however, no such false projection takes place, the sensory impressions here, as generally, being corrected by the muscular impressions, so that *D* is not seen at *E*, but in its true place.

These facts, which are of fundamental importance, may perhaps be put better in another way. Since the binoculus is simply the representative of the linked pairs of visual centers in the cerebral cortex and is therefore a representative of the combined retinas of the right and the left eye, every point in the retina of the binoculus projects like the corresponding point in the retina of each corresponding eye, but the projection is made with reference to the midline (bivisual axis) instead of with reference to the right or the left visual axis as it is in monocular vision. This means that when the left eye, *L* (fig. 2), is acting by itself, stimulation of a point, *b*, 15 degrees to the left of the fovea will be regarded as set up by an object 15 degrees to the right of the visual line *LA*; but when *L* is acting in conjunction with *R* (and under the influence of convergence), stimulation of *b* will be regarded as set up by an object 15 degrees to the right of *OA*. So, too, when *L* is acting alone stimulation of *a* will mean for it an object situated somewhere along *LA*, but when *L* is acting in conjunction with *R*, stimulation of *a* means an object situated on the midline *OA*, and in fact at its intersection with *LA*, i. e., at *A*.

Projection with Relation to the Visual Plane.—It is seen from the foregoing data that the effect of postural impressions derived from the equal converging efforts of the two eyes is to make the two project the object of binocular fixation along a line midway between them. But it must be added that, although convergence is the main factor concerned in effecting binocular projection, there is another element that must be reckoned with. This element is the postural impression derived from the actions of the elevator and depressor muscles which keep both eyes in what is called the visual plane and consequently always make one project the object of fixation to some point in that plane.

The visual plane is the plane passing through the object of fixation and the centers of rotation of the two eyes. It ordinarily, i. e., when both eyes are fixing, includes the two visual lines, *RA* and *LA* (fig. 2), but it will not do so if one eye is directed above or below the other. In that case, it includes the visual line of the fixing, but not of the deviated, eye. The visual plane can be tilted from side to side or up and down by movements of the head; and it can also be tilted up and down by the action of the elevator and the depressor muscles of the eyes.

The sensations arising from these combined movements of the head and the eyes inform one as to whether the plane is horizontal or tipped and whether the object of fixation is straight ahead or above or below one. For example, if sensations coming from the muscles of the head tell one that the face is directed straight forward and at the same time the sensations derived from the muscles of the eyes assure one that

the elevators are in equilibrium with the depressors, it is known that the visual plane is horizontal and that the object of fixation is neither above nor below. If the elevators, however, contract more strongly, and at the same time the depressors relax, while the head remains steady, the resulting sensations inform one that the visual plane is elevated, and the object of fixation, therefore, is above.

So far it would seem as if here I was merely repeating the conditions that govern monocular projection, but this is not the case. The movements of the eyes are strictly associated, so that when an impulse is sent to the elevators in one eye a precisely equal impulse is sent to the elevators in the other, and the like is true of the depressors. Hence when one eye gets such a combination of impulses as to make it rise 10 degrees, the other gets the same impulses. From each eye, then, is received an equal postural impression, making one aware that each is moving upward to the same extent and therefore occupying strictly the same plane. The object of binocular fixation is projected in this plane, the position of which is inferred from the equal postural impressions that the two eyes acting together afford. In the case supposed, the object, owing to the combined postural impressions derived from the muscles of the head and the two eyes, will appear 10 degrees above the level of the head. To rise to a point 10 degrees higher still would require an additional impulse for contraction transmitted to both right and left elevators and an additional impulse for relaxation transmitted to both right and left depressors; and these impulses would afford postural impressions indicative of the additional rise. Thus as postural impressions emanating from the convergence impulses and imparted always equally to both eyes make one project objects with reference to the bivisual line, so postural impressions emanating from the vertical movements and imparted equally to both eyes make one project objects with reference to the visual plane. An object that forms its image 10 degrees below the fovea in either eye is accordingly always regarded as situated 10 degrees above the visual plane, and not, or at least not necessarily, 10 degrees above the visual line of the eye in which the image is formed.

It follows, then, that the statement made in the preceding section that each point of the binoculus projects like the corresponding point in the retina of either component eye is general, being as true for points above or below the fovea as it is for points on either side of it. In either case the monocular projection that refers all objects to the individual axis *LA* or *RA* of the eye concerned is replaced in binocular vision by a projection that relates objects situated on the right and left to the bivisual line *BA* and relates objects situated above and below to the visual plane.

Projection by the Binoculus as an Explanation of Physiologic Diplopia.—It remains to consider how projection with the binoculus takes place when the retinal images of an object fall neither on the two foveae nor on any extrafoveal pair of corresponding points.

I shall first consider the conditions observed when one looks sharply at an object, *A* (fig. 2), and at the same time takes notice of objects *B* and *C*, respectively, nearer and farther than *A*. Both *B* and *C* appear double. In the former case, the images are crossed (image of the right eye on the left side); in the latter case, they are homonymous (image of the right eye on the right side).

The explanation commonly given for the fact that when the eyes are fixing *A*, *B* appears in crossed double images is that the left eye projects *B* out to *M*, and the right eye projects it out to *N* in the plane of *A*. But the most simple experiment serves to show that this is not true. If one holds up a pencil a foot from the eye and regards a wall one or two yards away, the pencil splits into two. The double images, however, merely separate laterally, so that the pencil appears no farther off after division than it did before. There is no appearance suggesting projection on the more remote wall. If there were such a projection, one would lose to a certain extent one's notion of the distance of the wall, since the images of the pencil, apparently coinciding with it, would no longer appear less remote. But as a matter of fact, the two images of the pencil appear, not on the wall, but as far away from it as ever, so that they still give as great an idea of the relative distance as before, and, moreover, the separation of the images gives an added clue to this, since the greater this separation, the farther away from the pencil the wall is judged to be.

The error in the current explanation lies in the fact that it is based on the assumption that in binocular vision each eye projects as it would if seeing monocularly. If each did so, there is really no reason why *B* should not appear single, since the left eye projects it along *LB* and the right eye along *RB*, and as it is not projected beyond its own place, the two images should lie at the point where *LB* and *RB* cross; i. e., they should be coincident.

The true explanation must fit the fact that when one looks at *A*, a nearer object, *B*, doubles and yet looks no farther off than before. The following interpretation of the facts (which is essentially that given years ago by LeConte [2]) aims to show that projection by the binoculus affords a ready means of accounting for this.

When the two eyes are fixing *A*, the images of *A* on the two foveae *a* and *x* are fused in the cerebral cortex and, as has been shown, are

2. LeConte, J.: Sight: An Expression of the Principles of Monocular and Binocular Vision, New York, D. Appleton & Company, 1881.

projected by the binoculus as from the bifovea, *f*, straight out along the midline *OA*. *A*, moreover, appears in about its true situation. As mentioned, it is exactly as if each eye had been transferred to the midline and *a* and *x* had each been swung in to coincide at *f*. But if the left eye projects from *a* as if the latter were at *f* it will project from *b*—the point occupied by the image of *B* and 15 degrees to the left of *a*—as if *b* were at *d* 15 degrees to the left of *f*. For necessarily the whole retina shares in the supposed rotation. The left eye image of *B* will thus be projected out from *d* and along the line *OI* 15 degrees to the right of *OA*. This corresponds to the fact that the same image produces an impression on the cerebral cortex that imparts the sensation of an object 15 degrees to the right of *A*, the object fixed by the fovea. Since the left eye image of *B* is thus projected out along *OI* and at the same time is judged to be no farther out than *B* itself, it is judged to lie at *I*. In a similar way, the right eye image of *B* is projected out from *v* 15 degrees to the right of *f*, along the line *OJ*, and is judged to lie at *J*. *B*, therefore, appears in the double images *I* and *J*, *I*, the left eye image, being on the right, and vice versa.

By a reasoning entirely analogous, it will be clear that *C*, more remote than *A*, will appear in homonymous double images, *K* and *P*, the former corresponding to the left eye image, *c*, the latter to the right eye image, *z*, and both lying in the plane of *C*.

It is evident that the farther either *B* or *C* is from *A*, the farther apart will be the double images that each produces.

One is not usually aware of this double vision, although with a little attention it is easy to develop it. This is especially true of the crossed double images of an object nearer than the point of fixation. Thus if one holds up a finger 1 foot from the eyes and in line with a light 10 feet distant and fixes sharply on the light, the finger separates into two shadowy images, one on either side of the light. That these images are crossed can be proved by shutting the right eye, in which case the left-hand image disappears.

If one then shifts one's gaze to the finger, the two images of the latter will come sharply together, so that the finger appears single and solid, and at the same time the light splits, the right eye image flying to the right and that of the left to the left. (That the right image does belong to the right eye can again be readily proved by shutting the latter.) This homonymous diplopia in the case of the more distant object is not so easy to demonstrate as the crossed double images of a nearer object.

It is easy to see that both of the double images in physiologic diplopia are indistinct and shadowy, so that one can see objects through them. This is especially true of an image that happens to lie directly in line

with the object of fixation. Thus, suppose that as one fixes an object *A* an object *X* is interposed in direct line between the left eye and *A*. To one looking with the left eye alone, *X* appears solid so as to cut off the view of *A*. When the right eye is opened and the gaze of both is fixed on *A*, the latter comes to view and appears clear, and one sees two images of *X*, one in line with *A*, and so shadowy that *A* can be seen through it, another rather more distinct, but still shadowy, to the left. The more the observer fixes his gaze on *A*, the more shadowy the directly interposed image of *X* becomes. *X* in this case becomes shadowy when seen by the left eye, not because its image occupies an extrafoveal portion of the retina, for its image occupies the fovea, but because this foveal image for which the eye refuses to accommodate and which it wishes to get out of the way is more or less suppressed.

Law of Binocular Projection.—It has already been pointed out that in monocular vision the effect of postural impressions is such that each eye, no matter how it is moved, projects as if it had not moved at all, and remaining thus motionless had judged simply by its visual impressions. For binocular vision a similar principle obtains, which may be thus enunciated:

When the two eyes are acting together, each contributes a visual impression that is first transferred to the midline and then projected, as it would be in monocular vision. In other words, in binocular vision projection by each eye is made as if each had been transferred to the midline and then, remaining motionless—i. e., neither converging nor making a conjugate movement—had projected as if guided by its visual impressions alone.

In this case, if the two component impressions have a like origin in the two eyes, i. e., either simultaneously affect the two foveae or simultaneously affect any extrafoveal pair of corresponding points, the object appears single; otherwise, it appears double. This statement, as will be shown, applies not only to physiologic but also to pathologic diplopia.

The Essential Difference Between Monocular and Binocular Projection.—Thus it is seen that the essential difference between monocular and binocular projection is that in the former each eye projects as if it were in its own place, and in the latter as if each eye were transferred to the midline. In monocular vision each eye projects with reference to its own visual axis, in binocular vision with reference to the midline or bivisual line.

The essential cause for the differences is found in postural impressions. In monocular vision these differences lead each eye to project from sensations derived from conjugate movement and in binocular

vision mainly from sensations derived from convergence. In the latter case, the sense of a convergence effort, emanating equally from the two eyes and impelling both toward the midline, necessarily gives the impression that the object looked at by both eyes is in the midline at a certain distance, and that as a necessary consequence it causes all other objects to be projected as though the midline were the visual axis.

The overmastering influence of the convergence impulse makes itself felt even when the two eyes do not converge on the same object, so that there is diplopia. In fact, diplopia can hardly be explained otherwise. For, as will be seen, an eye, even when deviating, habitually projects as though postural—i. e., convergence—impressions made it locate its visual axis in the bivisual line and made it refer its visual impressions to that line, just as the nondeviating eye does. Thus in figure 2 the right eye projects as though its visual axis *RC* were coincident with *OC*; in this regard, acting just like the nondeviating left eye. Thus one can still speak of a bivisual axis even though there is but one object of fixation. One may say, indeed, that in all but the most exceptional cases binocular vision is governed by convergence posture, as monocular vision is governed by conjugate posture.

In this broad presentation of the essential difference between monocular and binocular projection, I have passed over the effect of the vertically acting muscles, which, as I have stated, act in binocular vision to keep both eyes equally in the visual plane and thus determine the stability of the latter and cause the eyes to project with reference to it. But this, while an important factor in producing binocular projection, does so chiefly by aiding and supplementing convergence, which is the essential postural element concerned and which in any case affords the main distinction between monocular and binocular projection.

Sighting or Dominant Eye in Binocular Projection.—When, as in sighting a rifle on a target, one tries to look so as to keep two objects that are at different distances in line, it is obvious that one can do this only by monocular projection. If, for example, one uses the right eye for sighting, the left if it looks at the target will see the rifle—sight double—or if it looks at the sight will see the target double. Therefore, in this case one must choose with which eye one will sight. Most persons prefer to sight always with the same eye, usually the right, which is, therefore, called the dominant, sighting or directing eye ("oeil directeur" of Javal and Tscherning). In this case, whenever the eyes deviate from fixation and the conditions are such that the patient can choose with which eye he will fix, the dominant eye is chosen. However, this selection is by no means something fixed and inevitable. On the contrary, it is easy to get most persons to shift fixation from one eye to the other. For example, I have found that in plotting the diplopia on the tangent curtain, I can almost always make the patient fix with the left eye by simply placing the red glass before the right, and that too,

even though undoubtedly in most cases the right was the dominant eye. In such cases, too, I find that quite regularly the patients will shift fixation to the right eye, when the red glass is put over the left. For this reason I do not attach to the dominant eye the importance that others would ascribe to it. In the ordinary binocular projection of the normal-sighted, it certainly plays little part. No matter which is the dominant eye, each eye seems to contribute almost an equal share to the production of the added clearness and the much better perception of depth which binocular projection affords. For these added qualities which one obtains when looking with both eyes, suffer about an equal diminution when one closes one eye.

Those who have attached great importance to the dominant eye have divided mankind into two classes, right-eyed and left-eyed, and some have regarded the right-eye dominance in the former as due to the functional predominance of the left side of the brain. In this view a right-eyed person is or should be regularly right-handed. And, in fact, statistics support this view. Among the school children of Elizabeth, N. J., Parson[3] found 608 who were right-eyed; of these, only 4 were left-handed. On the other hand, 257 were left-eyed, and, while of these only 32 were left-handed, the evidence showed that a fairly large proportion of the rest were originally left-handed, having become right-handed simply through training. In his belief, which should command attention because of the intensive and careful study he has given the subject, right-handedness (dextrality) is the result of right-eyedness (dextrocularity), which is the primary condition. Nevertheless, I feel that, even granting the force of statistics like these, the fundamental point of view involved, which attributes right-eye dominance (dextrocularity) to left-brain dominance, is essentially fallacious. And, for the reasons already given, I am convinced that in the vast majority of people the dominance of the eye with which they prefer to sight is an unstable affair. It is easy to unseat one king and set up another, and then again to return the former tyrant to his throne. Believing this, I cannot agree with those who would regard the prevailing dominance of one eye as an important factor in producing motor anomalies and visual disturbances.[4]

The dominant eye can be determined in various ways. An efficient and simple method is that of Dolman.[5] The person examined holds at arm's length a card 5 by 8 inches (12.7 by 20.32 cm.) having a hole 3 mm. in diameter in its center. Through this hole he looks at a light across the room, and then determines by shutting one eye with which eye he has been sighting the light. Or, if, as he should do, he notices that he sees two holes, he notes whether he sees the light through the right or the left hole. If through the left, then he is sighting with the right eye, and vice versa. In order to prevent any suggestion derived from one-sided muscular action, the card should be held with both hands. The dominant eye can also be determined in testing the near point of convergence. When this is reached, the eye that remains fixing while the other diverges is, for near points at least, the dominant eye.

3. Parson, Beaufort, S.: Lefthandedness: A New Interpretation, New York, The Macmillan Company, 1924.

4. See Cf. the ingenious but, I think, somewhat fallacious ideas of Straub, Arch. f. Ophth., 1909, vol. 70, no. 1.

5. Dolman, P.: Am. J. Ophth. **3**:867 (Dec.) 1919.

THE PERCEPTION OF DEPTH; STEREOSCOPIC VISION

How Binocular Projection Produces Stereopsis.—Monocular and binocular projection are alike in one regard; both give orientation for objects in a transverse plane, and in both the relation of such objects to each other is afforded by visual projection, and their relation to the observer is afforded by postural projection. The only difference is that in monocular projection the situation of the object is referred from the eye viewing it, while in binocular projection it is referred from the binoculus.

If one were limited to orientation in a transverse plane, objects would appear much as they do in a photograph, giving no impression of distance or relief. Orientation of this sort is the characteristic feature of monocular projection, although monocular projection sometimes escapes from the shackles that confine it to one plane, and, mainly by the aid of adventitious factors not connected with the activities of the eye, affords some notions of depth. However, judgments of depth formed by monocular projection are fallible, uncertain and slow. The accurate perception of depth is dependent on binocular projection. How this produces it will now be considered.

In effecting the perception of depth and solidity several factors enter, and the relative importance of these factors varies greatly according to circumstances. These factors [6] may be divided into extrinsic, or those dependent on the character of the things seen, and intrinsic, or those dependent on the functioning of the eyes themselves. As thus divided, the factors are:

Extrinsic

1. Distinctness of outline.
2. Effects of light and shade.
3. Overlapping contours.
4. Motion parallax.

Intrinsic

(*a*) Either Monocular or Binocular

1. Size of retinal image (mathematical perspective).
2. Accommodative effort.

(*b*) Binocular only

3. Dissimilarity of retinal images.
4. Convergence effort.
5. Physiologic double images.

Extrinsic Factors Producing Stereopsis.—The extrinsic or adventitious factors are:

1. Varying distinctness of objects (atmospheric perspective). As distance lengthens, distinctness of outline diminishes. Everyone knows

6. The summary given follows in part the excellent presentation of Howard (Am. J. Ophth., April, 1919), and owes something also to the lucid description given by LeConte (footnote 2).

how the outlines of a distant landscape soften and blur, while nearer objects stand out distinct and clear. This factor naturally is much affected by atmospheric conditions, which may be such as to cause considerable errors in judgment. Thus in hazy weather, it is difficult to estimate distances correctly. Objects may look unusually far off, or, because all are blurred alike, all may look about equally remote. On the other hand, if the air is so clear that everything stands out with unusual distinctness, one often judges objects to be much nearer than they are. A mountain rising sharply against the sky in the clear rarefied atmosphere of the western plains may look to be only 5 miles distant, when it is really 20.

2. Contrasts of light and shade. The effect of deep shadows and high lights in producing an appearance of depth and prominence is well known. It is by these means that artists succeed in producing the effects of perspective in their pictures.

3. The effects of overlapping contours. When one sees one object partly hidden by another one naturally judges that the former is more remote. A procession of objects, each partly concealing the one behind it, gives an impression of distance that one fails to obtain from a single object. It is apparently for this reason that an object seen over a stretch of water with no intervening objects is habitually regarded as being nearer than it is.

4. Motion parallax, or the apparent shifting of objects on one another produced by the observer's own change of place. An example of this factor is the way one gages the relative distance of objects that one passes when on a railway train. Things near one, e. g., the telegraph posts, appear to be flying backward, while things more remote seem to be flying with one. This must be one of the main means of determining distance possessed by animals whose eyes are set in the side of the head, as they cannot both see the same object at the same time.

It is obvious that the extrinsic factors are as operative in monocular as in binocular vision.

Intrinsic Factors Producing Stereopsis.—The remaining factors effecting stereopsis are dependent on the action of the eyes themselves. The way in which they act is indicated graphically in figure 2. Of these intrinsic factors, two are operative both in monocular and in binocular vision. These are:

1. The varying muscular effort involved in accommodating on objects at different distances. This factor cannot have much influence, except when the objects are comparatively close. It is possible, however, that it may act in helping to determine the distance of objects which are as far from the eye as 3 or 4 meters.

2. The size of the retinal image (mathematical perspective). This factor is of considerable importance, especially in gaging the distance of objects of known size. Trained observers, e. g., those skilled in rifle practice, can form quite accurate estimates of distance in this way. This factor comes particularly into play in determining distances by receding lines which converge in mathematical perspective, as, for example, when one looks down a long straight street, one sees the houses on either side diminishing steadily in size and the street itself gradually narrowing down to the vanishing point.

The remaining factors are effective in binocular vision only. These include:

3. Dissimilarity between the retinal images of an object in the right eye and those in the left. As already stated, this dissimilarity may be due to the fact that one eye in looking at any object having more or less depth sees a portion of it that the other eye does not see. Dissimilarity of images due to a different point of view comes especially into play with objects that are quite close to the eyes, since then proportionately more of what is visible to one eye will be hidden from the other, so that the difference in the impressions received by each will be marked. However, the dissimilarity in impressions may be caused in other ways than by differences in point of view, being produced, for example, by differences in color, luminosity, etc.

Dissimilarity in images is not a necessary factor in the production of the perception of depth. The object, even when observed from the differing point of view of the two eyes, may look precisely alike to each, and yet afford impressions of depth. This is the case, for example, when, as in Howard's apparatus, the object viewed is a uniformly illuminated cylindrical rod.

4. The muscular effort involved in converging on objects fixed. In this case, again, the effect is reinforced by the fact that the effort varies as the eye ranges back and forth from objects nearer to objects more remote.

Some, indeed, have ascribed the perception of depth quite specially to the fact that the eye thus ranges, making, as it does then, continually varying adjustments and getting continually varying impressions, both visual and muscular. But perceptions of distance can be had under conditions of absolutely momentary vision, when it would be impossible for the eye to execute any ranging to and fro. For example, they can be had in the case of distant objects suddenly illuminated by lighting and as suddenly swallowed up again in darkness. In this case, there would not be time for a convergence effort; it would seem that the only factor operative would be the perception of physiologic double images (LeConte).

5. The presence of physiologic double images. As has been seen, when one focuses both eyes on an object, *A*, a nearer object, *B*, appears

in crossed images and a more remote object, *C*, in homonymous double images. In the case of *B*, the diplopia is made to diminish and ultimately disappear by diverging the eyes still more. With *C*, the reverse is the case. Continual experiences of this kind make one instinctively aware that images such as *I* and *J* formed by an object *B* must belong to a nearer object than *A*, and furthermore that the farther apart these images are the more distant *B* must be from *A*. This sort of projection is a combination of visual and postural impressions, but more particularly the latter, since it is the varying convergence effort that is the basis of the difference in the visual impressions.

The binocular factors, particularly factors 4 and 5, afford by far the most reliable and accurate estimates of depth and distance. Howard [7] showed that under ordinary conditions they greatly surpass in this regard the monocular factors (such as mathematical perspective). They act also with remarkable precision. Howard [7] showed that by binocular projection a good observer could tell which of two objects, *A* or *B*, was nearer, when the difference between the angles by which the two eyes converged on *A* and *B*, respectively, was less than 8 inches.

Such a minute angle means that the retinal images of *A* and *B* have been shifted over a space much less than the diameter of even the smallest retinal cone. Andersen and Weymouth [8] obtained even smaller values indicating that the amount of a still perceptible variation in the position of a retinal image ranges from 0.074 to 0.216 microns, while the diameter of a retinal cone in the macular region ranges from 1.5 to 5 microns. Since each retinal cone presumably furnishes its individual impression, which impression is set up to an equal degree by any part of the cone, it would appear as if the retinal impressions in order to be distinguished from each other should regularly be separated by at least the diameter of a cone. However, the sensitivity of the retina is evidently many times greater than this supposition would imply. Various hypotheses have been advanced to account for this extreme accuracy of perception. Andersen and Weymouth expressed the belief that it may be explained by what they call the "mean local sign" of the retina. In the first place, they assumed that each cone, by constant association with the four or five cones adjoining it, becomes linked with them physiologically so that each of a set of half a dozen will have a similar representation in consciousness; i. e., they will afford a similar space perception or "local sign." Furthermore, as is known, in fixation the gaze shifts slightly so that the retinal image sweeps from one row of cones to another. These sensations thus set up in a series of adjoining cones, which are thus physiologically linked produce a composite impression, which affords a space perception ("local sign") that represents the mean of the individual local signs. This mean gives a more precise measure of localization than does each of its constituents, just as the mean of a number of each inch measurements may be precise to a small fraction of an inch.

Of course, such extreme sensitivity as this is found only under the special conditions of laboratory experiments. In ordinary circumstances the discernment of

7. Howard, H. J.: Am J. Ophth. **2**:656 (Sept.) 1919.

8. Andersen, E. E., and Weymouth, F. W.: Visual Perception and the Retinal Mosaic, Am. J. Physiol. **64**:561 (May) 1923.

differences in the parallactic angle would not be nearly so sharp. As an offset, there would be present in this case the other factors, extrinsic and intrinsic, mentioned, which in the laboratory tests are excluded, and which, especially the extrinsic, are often of material importance in the estimation of distance. Of the intrinsic factors entering into judgments of depth and distance, two, viz., accommodative effort and converging effort, are examples of postural projection, and two, viz., the size of the retinal images are visual. The fifth, i. e., the perception of physiologic double images, contains both visual and postural elements.

Other Conditions Affecting the Perception of Depth.—The operation of the various factors enumerated, both extrinsic and intrinsic, is greatly affected by the condition of the eyes themselves. It varies particularly with the visual acuity, the light sense and the state of the motor apparatus. It is also greatly affected by the character of the objects looked at.

Subjective and Objective Orientation Produced by Binocular Projection.—It is apparent from the foregoing factors that in binocular even more than in monocular vision the localization of objects in space is a complex process compounded of various visual and postural elements.

In both monocular and binocular vision, objective orientation, or the ascription of external objects to this place or that in relation to one another, is dependent on the fact that the images of these objects occupy different places on the retina. Objective orientation, then, is due to visual projection. But even here there is probably a basic postural element. Thus it may be said that *A* appears to the right of *B* because the retinal image of *A* is to the left of that of *B*, but if one examines the matter more closely one may well believe that the reason why this left-handed position of *A*'s image gives an impression that *A* itself is on the right hand is that the left-hand position of the image means that the eye must move to the right to get that image on the fovea.

Subjective orientation is more complex. Both in monocular and in binocular vision orientation of objects in a transverse plane, or the impression that they are to the right or the left, or above or below, is due to postural projection. In this case the postural sensations are derived either from movements of the head or from conjugate movements of the eyes. But even here a certain amount of subjective orientation is afforded by visual projection. That is, the sense that *B* is above *A* likewise is translated to mean that *B* is higher than one is, provided one regards *A* as straight ahead. Thus if postural projection enables one to locate the position of just one external object with regard to oneself, visual projection will give one accurate information as to the positions of all the others. In fact, this is the sort of cooperation that regularly obtains between the two, postural projection effecting subjective orientation of the object fixed and visual projection effecting objective, and thereby subjective, orientation of all other objects.

Subjective orientation in a fore-and-aft plane, i. e., the impression that an object is nearer or more remote, is a complex of visual and postural projection. The visual elements are partly those afforded by differences in the appearance of the objects themselves and partly those afforded by perspective or by the dissimilarity of the retinal images; the postural elements are those derived from the muscular efforts involved in accommodation and in convergence. The most potent element of all (physiologic double images) is partly visual and partly postural in origin.

To sum up the matter, visual projection gives one the notion of the shape of objects, their relative and, to a certain extent, their absolute size and their position with regard to one another either in a transverse or in a fore-and-aft plane. However, postural elements enter into these judgments, especially the latter. Postural projection gives one notions of the erectness of objects, and tells one whether they are straight ahead, to one side or above or below. Finally, both elements, visual and postural, combine to tell one how far away external objects are.

SENILE CATARACT

THE USE OF PARATHYROID EXTRACT *

DANIEL B. KIRBY, M.D.
NEW YORK

Before it was learned that the calcium metabolism of patients with senile cataract was within normal limits, and that they did not need treatment with parathyroid extract, it was thought that possibly they might benefit from the use of the latter. There had come to my attention certain unpublished reports on the use of various parathyroid extracts with more or less success. As calcium enters into the mechanism of so many physiologic processes, Collip thought it possible that clinical research would later indicate that it was desirable under definite circumstances to keep certain patients in a state of mild hypercalcemia. Besides, there were other possibilities: 1. Although the greater percentage of patients with cataract had more than sufficient calcium in their blood serum, the amount that was diffusing into the aqueous was insufficient to keep up a proper balance. 2. There was an excess of calcium in the aqueous, vitreous and lens in the early stages of cataract, and the use of the parathyroid extract would help remove some of the excess and favor excretion.

These matters have been cleared up greatly in the progress of a study of calcium in relation to cataract, and the answer to these questions was given in a previous report. However, as it was important to know the action of parathyroid extract in cases of cataract, the most potent and the only reliable form, parathormone, was administered in selected cases.

EFFECT OF DAILY INJECTIONS OF PARATHORMONE IN CASES OF CATARACT

Six patients with cataract were given five daily subcutaneous injections of parathormone in doses of 1.5 cc. (30 units).

Most of the patients had fairly well advanced cases of cataract, in which one might suspect from the appearance of the cataracts that there were deposits of calcium in the lens. None of the patients showed improvement, and there was no absorption of the cataractous material.

One patient, A. P., a man, aged 60, with corticonuclear cataracts, whose serum calcium was 10 mg. per hundred cubic centimeters, was

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given 50 units of parathormone daily for seven days without any absorption of the cataract. The serum calcium rose to 10.62 and 10.8 after the injections.

EFFECT OF INJECTIONS OF PARATHORMONE OVER A PERIOD OF ONE MONTH

Five cases of incipient and immature cataract were selected, and parathormone was administered in 1 cc. doses (20 units) subcutaneously.

TABLE 1.—*Results of Injection of Parathormone in Six Cases*

Case	Sex	Age	Type of Cataract	Vision		Serum Calcium Before Injections	Serum Calcium After Injections	Comment
				Right Eye	Left Eye			
224316	M	30	Posterior cortical	20/70	20/70	10.5	10.1	Retinitis pigmentosa
241430	M	68	Cortical	Light perception	20/200	9.6	9.9	Extraction of right lens
70725	F	69	Cortical	20/50	20/40	9.8	10.6	Hemorrhagic retinal glaucoma
86156	F	58	Cortical	Hand movements	Light perception	10.0	10.3	Diabetes; extraction
225267	F	58	Cortical	Hand movements	20/70	10.1	10.3	Extraction of right lens
229153	F	56	Cortical	Light perception	20/70	10.8	11.5	Extraction of right lens

TABLE 2.—*Results of Injection of Parathormone for One Month*

Case	Sex	Age	Type of Cataract	Vision		Serum Calcium		Units of Parathormone in One Month
				Right Eye	Left Eye	Before	After	
256661	F	68	Corticonuclear	20/70	20/100	10.0	8.9	180
258817	F	68	Cortical	20/40	20/50	10.6	12.1	180
258835	F	45	Posterior cortical	20/50	20/20	....	12.1	260
218834*	F	54	Cortical	20/40	20/40	10.6	9.0	240
196661†	F	50	Cortical	20/40	20/40	11.5	10.5	200

* Arrested pulmonary tuberculosis.
† Hypertension.

On reexamination, after the injections were stopped, no changes were noted in the opacities of the lenses. The vision and refraction remained the same. It is interesting to note that three of the cases actually showed a diminution in serum calcium, the amount being determined two days after the last injection. One cannot expect the effect of doses of parathormone such as these to be continued for longer than fifteen hours. Undoubtedly, there is a fluctuation of the level of serum calcium within the normal limits in patients who have normal calcium metabolism.

EFFECT OF THE ADMINISTRATION OF PARATHORMONE OVER A LONG PERIOD TO PATIENTS WITH CATARACT

CASE 1.—F. O., a white man, aged 75, was first seen in February, 1927, with incipient, senile, cortical cataracts. The changes in the lenses consisted in water-split sutures with a few morgagnian globules in the clefts, and faint lamellar separation in the inferionasal quadrants. Vision in the right eye was 20/200 with +2.50 sphere, and in the left eye, 10/200 with +2.50 sphere. This great reduction in vision was due to a large area of macular degeneration in each eye. The condition was vascular in origin, there having been leakage from the capillaries in the choroid in the macular area. This case was selected because the psychic factor and the matter of visual acuity would not be important in judging the effect on the opacity of the lens. On Oct. 30, 1928, when the patient was first given parathormone, the only changes from the previous year were in the graying of two of the morgagnian globules. The blood serum calcium was 11 mg. per hundred cubic centimeters. Parathormone was administered subcutaneously, 1 cc. at a time, each dose representing 20 units, on the following dates: 1928, October 30; November 1, 3, 7, 9, 12, 14, 19, 21, 23, 26, 28, 30; December 3, 5, 7, 10, 12, 14, 17, 19, 21, 24, 26, 28; 1929, January 4, 7, 9, 11, 21, 23, 28, 30; February 4, 6, 8, 11, 13, 19, 25; March 4, 6, 8, 11, 18, 25; April 1, 9, 17, 24. Approximately 1,000 units of parathormone was used over a period of six months.

In April, 1929, fresh hemorrhages appeared in the macula of each eye. It is believed that the parathormone did not contribute to the production of the hemorrhages, but it was considered interesting at the time that the long-continued use of the parathormone had not served to prevent their occurrence.

The water-split sutures and globules and the lamellar separation remained unchanged during and after the injections. Reexamination was made on July 10, 1930, and there was observed extension of the split sutures in each lens, a greater number of globules, with more that had become grayish, and a moderate increase in the lamellar separation, with haziness of the cortex in that area. The vision had decreased somewhat in each eye owing to extension of the macular lesion.

CASE 2.—J. M., a white man, aged 62, had a senile cortical cataract superimposed on a heavily sclerosed nuclear opacity, with an amber reflex. Vision in the right eye was 20/40 with +2.00 sphere; in the left eye, 20/50 with +1.50 sphere. The blood serum calcium was 9.4 mg. per hundred cubic centimeters.

On Sept. 4, 1928, vision in the right eye was 20/70; with a +2. lens, it was 20/40; that in the left eye was 20/70; with a +1.50 lens, it was 20/50.

The patient was in a good general physical condition. He was given 1 cc. (20 units) of parathormone on the following dates: 1928, October 30; November 1, 3, 7, 9, 12, 14, 19, 21, 23, 26, 28, 30; December 3, 5, 7, 10, 12, 14, 17, 19, 21, 24, 26, 28; 1929, January 4, 7, 9, 11, 14, 18, 21, 23, 25, 28, 30; February 1, 4, 8, 11, 13, 15, 18, 20, 25, 27; March 1, 4, 8, 11, 13, 15, 18, 20, 22, 25, 27, 29; April 1, 3, 10, 20, 22, 24, 29; May 6, 13, 20, 27. A total of 1,380 units of parathormone was given. A gradual progress of the opacity was noted. It became necessary to extract the cataract from the left eye in September, 1929, and from the right eye in March, 1930. An excellent visual result was obtained in each eye following operation. No retinal hemorrhages were evident.

In this case a steady progress of the opacity of the lens was noted until useful vision was lost. The injections of parathormone apparently

had no effect in absorbing or retarding the cataract. The cataracts were removed by operation, and the resulting vision with correcting lenses was excellent.

CASE 3.—J. F., a white man, aged 70, was seen first in February, 1927, with one water-split suture and two minute globules in the right eye. The left eye showed no evidence of hydration of the cortex, only a sclerosed nucleus. With a correcting lens of +2.50 sphere +0.75 cylinder and axis × 180, the vision in the right eye was 20/30; in the left eye, with +2.00 sphere +0.50 cylinder and axis × 180, it was 20/30.

Physically, the patient showed some evidence of arteriosclerosis and myocardial insufficiency. In February, 1928, there was observed the development of a faint lamellar separation in the inferionasal quadrant of each eye with one minute vacuole beneath the capsule of the left lens. The water-split suture had remained practically unchanged. The blood serum calcium was 8.44 mg. per hundred cubic centimeters. The patient was given parathormone in doses of 1 cc. (20 units) on the following dates: 1928, November 13, 15, 20, 27, 30; December 4, 6, 10, 12, 18, 20, 26; 1930, January 8, 10, 12, 15, 25, 28, 30; February 4, 6, 8, 11, 15, 20; March 4, 11, 27; May 3, 24. He was not as regular in attendance as the other two patients and pleaded the severity of the wintry weather. He received a total of approximately 600 units of parathormone during six months.

Practically no change was perceptible during the six months he received the injections. The refraction and vision did not change. He was reexamined on July 10, 1930, and it was found that the clear fluid of the water-split suture had been replaced by opaque material in a spoke which was smaller than the water-split suture. There was more lamellar separation. The vacuole remained unchanged. The vision of the right eye was the same, while that of the left eye had diminished to 20/50, not through progress in the cataract, but through the development of a hemorrhagic retinitis.

There is no indication that the cataract which complicates tetany is analogous in any way to the average senile cataract. There is no evidence of a deficiency of parathyroid or calcium in patients with senile cataract. The serum calcium is sufficient and undoubtedly furnishes enough calcium by diffusion to the aqueous, vitreous and lens. It is therefore unnecessary to attempt to raise the blood serum, aqueous, vitreous or calcium content of the lens. The use of parathyroid extract for this purpose is therefore not indicated.

Adams felt that there was a slight excess of calcium in her cases of cataract, but not to a degree sufficient to cause opacity of the lens. In my series of cases the averages were within the upper limits of normal. It is hardly necessary to give these patients parathyroid extract in order to excrete the excess calcium, as this would not reduce the level of the serum calcium. The latter is raised by the hormone as increased excretion goes on.

It is not likely that parathyroid extract will accomplish the removal of excess calcium from the lens once opacities have formed. The

hormone mobilizes calcium, but the great storehouse of calcium in the fine spicules of bone, ramifying in the bone marrow, will be depleted before deposits such as are found in cataract will be attacked.

It may be said that the series of cases on which parathyroid extract was tried is small, but in view of the fact that there is no need for the hormone and in the greater majority of cases it was definitely contraindicated, there was no need for carrying the clinical test any further.

The evidence that a cataract has remained stationary for a certain period is not sufficient proof that the treatment has been effective in causing the standstill, as it is common knowledge that numerous cases of cataract do this without any treatment. For a certain treatment to be judged efficacious, it should cause absorption of existing opacities in some cases. Cataracts do not progress evenly and regularly, but by fits and starts, and often there is a long period of intermission between the stages.

The failure of parathormone to cause absorption of the opacities of the lenses in these cases in no way reflects on the value or efficacy of this agent in cases of deficiency in calcium, in which it is indicated. The three patients were given sufficient units to get a physiologic effect when one considers that there was no evidence that they were not secreting a normal amount of the hormone themselves. Collip estimated this to be about 45 units daily. Aub found that a refractory state developed after a few weeks of treatment in many of his patients. In the average case, repeated injections of parathormone cause a rise in serum calcium, which is sustained for varying periods. Gradually, there is less and less response. If the dose is increased, there will again be a rise, but finally there is no further response. However, if the patient is then given ammonium chloride, the serum calcium will again be increased, showing that the patient still has mobilizable calcium but has become refractory to parathormone. In the case of the three patients with cataract who were given parathormone for a period of six months, there was no reason for continuing the injections.

SUMMARY AND CONCLUSIONS

It was learned from another study of calcium in relation to cataract that the calcium metabolism of patients with senile cataract was within normal limits, and that they did not need calcium or parathyroid therapy. However, for various reasons the use of parathyroid therapy in such cases had been instituted, and it was carried through.

Three series of patients were treated, one series with daily injections of 30 units of parathormone, the most effective parathyroid extract, for five successive days; a second series with injections of 20 units,

three times weekly for a period of one month, and a third series with 20 units approximately three times a week for periods of several months, without any improvement in the vision, refraction or objective appearance of the cataracts.

The failure of parathormone to cause absorption of the opacities of the lenses in these cases in no way reflects on the value of this agent in cases of deficiency in calcium, in which calcium and parathyroid therapy is indicated.

RETINAL DETACHMENT

A METHOD OF ACCURATELY LOCALIZING TEARS *

ALFRED COWAN, M.D.
AND
LEO F. McANDREWS, M.D.
PHILADELPHIA

The attempt to localize retinal lesions is not new. In 1882, von Graefe [1] described his method of localizing a retinal cysticercus cyst. He also invented a new type of ophthalmoscope to be used in such cases. His method embodied several principles that are in use today.

Accurate localization of a retinal tear is a difficult procedure. The reason is obvious. One is working with many variable factors, e. g., the cooperation of the patient, the possible movement of the detached retina containing the tear, the length of the globe and the surgeon's judgment in estimating distance. No method, therefore, is free from error.

At the present time various methods are employed. Schoenberg,[2] in a recent article, described the method that Gonin employs. He locates the retinal tear with the ophthalmoscope, and ascribes it to a meridian corresponding to the hour hand of the clock. A black silk suture is then passed across the cornea in the direction of this meridian. The distance of the tear from the ora serrata is estimated in disk diameters. Each disk is considered 1.5 mm. in diameter. The ora serrata is placed at 8 mm. from this limbus. The sum of these distances is the total distance from the limbus.

In the hands of Gonin, this method has given excellent results. For others, less able, it may prove inaccurate. Bearing in mind that the diameter of the disk is about 1.5 mm. and that many retinal tears are often no larger than a quarter of the disk in size, an error of only 0.5 mm. is sufficient to miss the tear completely. Moreover, the number of disk diameters from any landmark depends on the observer's estimation of distance, which is often inaccurate.

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* Submitted for publication, Feb. 28, 1931.

* Read before the Section on Ophthalmology of the College of Physicians of Philadelphia, Feb. 19, 1931.

1. von Graefe, A.: Epikritische Bemerkungen über Cysticercus Operationen und Beschreibung eines Localisierungs-Ophthalmoscops, Arch. f. Ophth. **28**:187, 1882.

2. Schoenberg, M.: The Gonin Operation for Detachments of the Retina, Arch. Ophth. **3**:684 (June) 1930.

Lindner's [3] method is more elaborate. The patient's eye is centered by means of a Gullstrand ophthalmoscope, containing cross hairs, which is held in place by a special form of apparatus. Attached to the ophthalmoscope is a perimetric arc the radius of which is 33 cm. The center of this arc is about 32 cm. from the patient's cornea. On the arm of the perimeter is a small, movable point of light. The patient is told to move his eye along this arc following the point of light until the retinal lesion appears in the center of the ophthalmoscopic field. The angle is then read from the perimetric arc, and its meridian is also noted. Having found this angle, Lindner turns to his charts and determines the corresponding distance of the lesion from the limbus. In order to locate this point on the surface of the eyeball, he uses a small model, shaped like the peripheral part of a contact glass. This model is slightly larger than the cornea and has fixed at its center a movable arm which reaches beyond the limbus. The arm is long enough to indicate the distance of the tear from the limbus and also its correct meridian. The model is sutured to the conjunctiva near the limbus, so that the horizontal meridian of the cornea and that of the model coincide. The location of the tear is then marked with the cautery on the sclera. The model is now removed, and the operation is performed.

To obtain the correct distance, Lindner assumed that the anteroposterior diameter of the globe is 24 mm. The second nodal point is 17 mm. from the posterior pole of the globe, including the sclera. He obtained the distance of the tear by the following formula in which *B* is the unknown distance; *a*, the angle found on the perimeter and *r*, the radius of the globe (12 mm.):

$$B \frac{a}{180} \times 3.1416 \times r$$

Lindner seems not to have been aware that this is exactly the principle used by one of us (A. C.), in 1920 and in 1921, for measuring retinal lesions on a perimetric chart; but he applies it incorrectly in that he gives 180 as the number of degrees that would be covered not by the whole surface of the retina, but by one-half the circumference of the eyeball. This means that the retina ends at the equator of the globe, instead of at the ora serrata. According to Lindner, one degree in the field would equal 0.2 mm. on the retina of an emmetropic eye, when, as a matter of fact, it equals 0.25 mm. Besides, he assumed that the radius of the eyeball is 12 mm. This figure is too large, as will be explained later. But even with this figure, it will be found that, after deducting 28 mm. from the total circumference to allow for the anterior segment

3. Lindner, K.: Ein neurer Weg zur Lagebestimmung von Stellen des Augenhintergrundes und seine Verwendung bei der Goninschen Behandlung der Netzhautabhebung, Arch. f. Ophth. **153**:233, 1929.

of the globe which contains no retina, the retina would still cover about 47.3 mm. of the inner circumference of the globe. If this distance is divided by 180, the result will be 0.25 mm.

Lindner also stated that he can obtain by his method an angle up to 70 degrees. In our experience, the greatest amount of rotation of the eyeball that a person is able to maintain with any degree of comfort is usually about 50 degrees. This coincides with the figures given in the textbooks. Even if an angle of 70 degrees were obtainable, it is, in the majority of cases, not large enough to reach the retinal tear. According to our calculations, it would exclude any lesion in front of the equator of the globe. Most of the tears occur in the zone betweeen the equator and the ora serrata. We have found that the perimetric angle must be supplemented by another angle. This second angle is obtained by the observer.

Salzmann [4] incorporated the method described by von Graefe. The patient fixes his eye on the center of the perimetric arc, and the observer moves his ophthalmoscope along the arc until he finds the retinal tear. The angle and its meridian are read from the arc. To locate the tear on the sclera, three factors must be determined: the meridional plane, the line in this meridional plane and the point in this line at which the retinal tear lies. Salzmann explained how to determine these points. Detailed instructions are given, but the method is too elaborate and seems too intricate for the average observer. He makes no allowance for the angle obtained by the observer. He also estimates the locus of the tear by retinoscopy, in our opinion a difficult procedure.

One of us (A. C.) [5] projected the entire retinal surface on to a flat plane in which the anterior limit of the retina, corresponding to the ora serrata, extends 90 degrees in all directions from the fovea. It was concluded that each degree in the field is equal to nearly 0.25 mm. on the retina, and on this basis a perimetric chart was lined with squares, the sides of which would correspond to 1 mm. on the retina. We have found that these perimetric charts are useful in estimating the position of any lesion of the fundus.

The calculations are based on the assumption that the inside diameter of the globe is 22 mm. It might be objected that such an eye is too small. But one must remember that the retina is being measured, and that it lines the interior of the eye. The generally accepted external anteroposterior diameter of the globe is nearly 24 mm. If this is so, the internal anteroposterior diameter is no more than 23 mm. Merkel, quoted

4. Salzmann, M.: Ortbestimmung im Augeninneren, Arch. f. Ophth. **153**:252, 1929.

5. Cowan, A.: A Suggestion for a New Perimetric Chart, Am. J. Ophth. **3**:49, 1920; Perimetric Chart Used for Measuring Retinal Lesions, ibid. **4**:28, 1921.

by Whitnal,[6] gives 22.5 mm. as the average internal anteroposterior axis of the globe, and since a spherical area is desired, some allowance must be made for the shape of the anterior chamber. Assuming that the interior of the eyeball is a sphere, it is felt that 22 mm. is the best general average. However, between an eye 22 mm. long and an eye 28 mm. long, a refractive difference of 18 diopters, the difference per degree is only about 0.07 mm. For clinical purposes, therefore, the chart appears sufficiently accurate for any case.

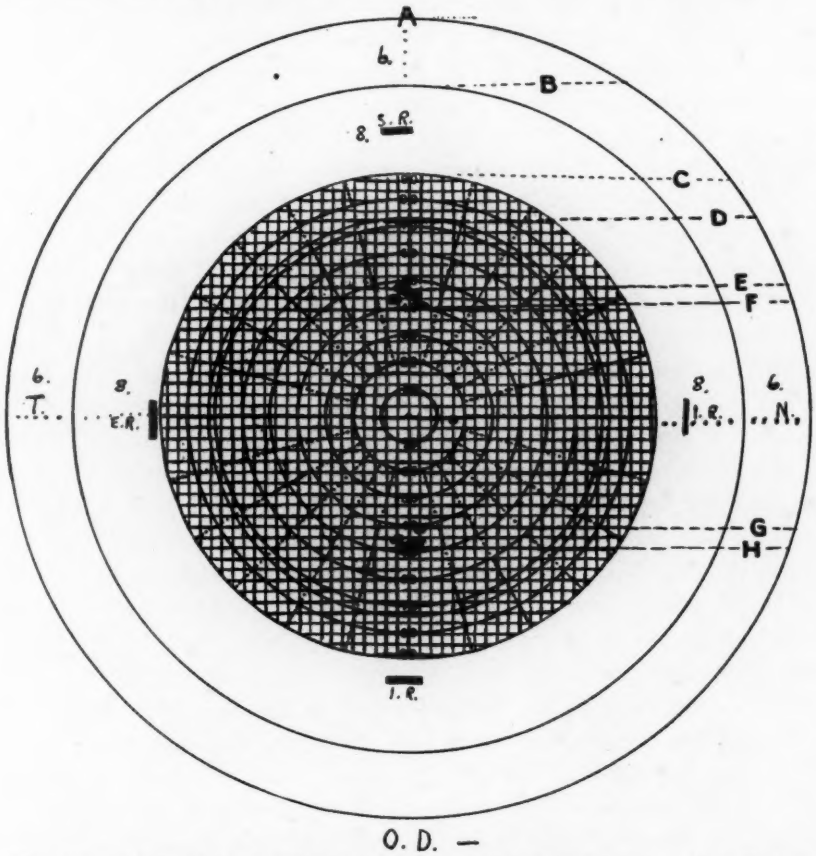

Chart used as aid in localizing tears in retinal detachments. *A* indicates the center of the cornea; *B*, the limbus; *C*, the ora serrata; *D*, equator; *E*, superior oblique muscle; *F*, the superior vena vorticosa; *G*, inferior vena vorticosa; *H*, inferior oblique.

By our method, the patient is placed chin in chin-rest, at a distance of 0.5 meter from a tangent screen, the affected eye on a level with and directly in front of the fixation point. He is told to rotate his eyes along the horizontal meridian as far as he can with reasonable comfort.

6. Whitnal, S. E.: Anatomy of the Human Orbit, London, Oxford University Press, 1921, p. 254.

A small light is moved along the screen until its image is in the center of the cornea. A pin is placed in the screen at this point, and the patient is told to fix his eye on this point during the examination.

The examiner now locates the lesion with the ophthalmoscope, using whatever angle is necessary. An assistant, with a meter stick or a piece of string, projects the line of direction, found by the examiner, back to the tangent screen. A mark is placed on the screen at this place. Von Imre [7] ties one end of the string to the ophthalmoscope, while the other end is held in the position of the optic axis of the globe.

The second angle found by the examiner must be corrected. In this oblique direction the rays of light emerging from the eye are bent away from the perpendicular, and the observer, falsely projecting these rays too far forward in the retina, places the lesion farther forward than it actually is. For practical purposes we may consider the ratio of the sines equal to the ratio of the angles of incidence and refraction in the proportion of 4:3. The horizontal and vertical angles used by the observer are, therefore, decreased by one-fourth. The angle through which the patient's eyes are turned, which is actual, remains unchanged.

For example, it was found that the patient could turn his eye 50 degrees to the right. To locate the lesion, the examiner used another angle of 40 degrees on the horizontal and 20 degrees above. Reducing the horizontal angle of 40 degrees by one-fourth, it becomes 30 degrees. The total angle, therefore, in the horizontal meridian is 80 degrees. We must now correct the angle above the horizontal plane. This angle reduced by one-fourth becomes 15 degrees. The final point, indicating the retinal tear, is now placed on the screen 80 degrees from its center on the 15 degree meridian.

It now remains to find the corresponding point on the sclera. As was previously stated, the periphery or 90 degree circle on the chart corresponds to the ora serrata, which according to the accepted figures, lies 8 mm. behind the limbus. Supposing that we have located our point on the 15 degree meridian and 80 degrees from the center: By dropping a perpendicular from this point to the horizontal meridian, it will be found to lie 3.5 mm. from the periphery of the 90 degree circle. The 90 degree circle lies 8 mm. behind the limbus. Adding the 3.5 mm. to this figure, we have the lesion located 11.5 mm. behind the limbus on the horizontal and 5 mm. directly above this point.

Moreover, on this chart can be placed the position of the vorticose veins, the attachments of the recti and oblique muscles and the entrance of the ciliary vessels, thereby showing at a glance what anatomic structures must be avoided.

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7. von Imre: A Simple Method for Localizing Retinal Tears, Klin. Monatsbl. f. Augenh. **84**:90, 1930.

CONCLUSIONS

An ordinary perimetric chart, scaled in the proportion of 0.25 mm. for each degree in the field, may be used as a plan of that portion of the interior of the eyeball which is covered by the retina.

With the aid of such a chart and the method described, we have a simple and accurate means of determining the anatomic location of any visible lesion of the fundus.

HETEROPHORIAS

I. A NEW TEST FOR VERTICAL PHORIAS, WITH OBSERVATIONS ON PATIENTS WITH PRESUMABLY NEGATIVE HISTORIES *

S. V. ABRAHAM, M.D.
CHICAGO

Many new tests for heterophorias have been described by as many different authors. All of them, however, are much alike in that no new fundamental principles have been introduced. Since von Graefe [1] described his diplopia test for excess of divergence, in 1857, many others have used minor variations of it. This type of test depends on the suspension of the fusion sense by creating an insurmountable diplopia in one meridian and by measuring the manifest phoria in the opposite meridian. The other type of test, of which the Maddox rod test is the best example, depends on a similar suspension of the fusion sense by producing so much distortion of one of the images that fusion is practically impossible. The manifest deviation can then be measured by prisms.

In 1886, Stevens [2] emphasized the importance of heterophorias and gave his widely used classification of the different types. He early defined heterophoria as a tending of the visual lines in some other directions but with the ability to adjust them habitually for single binocular vision. Wells [3] listed six causes of this condition, as follows: (1) malposition of the cranium and orbits; (2) abnormal power of one or more muscles; (3) tendons which are either too long or too short; (4) insertions of muscle tendons too far forward or back; (5) errors of refraction, and (6) incomplete development of the fusion faculty.

There seems to be no agreement as to the shape of the head or the direction of the anteroposterior axis of the orbit in relation to each type of heterophoria. As far as the vertical phorias are concerned, it is of interest to note, as Peter [4] said, "that while the anteroposterior axis

* Submitted for publication, Dec. 3, 1930.

* Further studies on this subject are in preparation.

* From the Department of Ophthalmology, University of Chicago.

1. von Graefe, A.: Insufficienz der inneren Augenmuskeln, Arch. f. Ophth. **3**:308, 1857.

2. Stevens, G. F.: Nomenclature des differents états reunis sous le nom d'insuffisance musculaire, Arch. d'opht. **6**:536, 1886.

3. Wells, D. W.: Stereoscope in Ophthalmology, Boston, E. F. Mahady Company, 1926, p. 31.

4. Peter, L. C.: Extra-Ocular Muscles, Philadelphia, Lea & Febiger, 1927, p. 20.

of the orbit forms an angle of approximately twenty-three degrees with the optic axis, it practically coincides with the muscle plane of the superior and inferior recti muscles." Asymmetry in regard to the horizontal plane is more than likely a factor in producing a motor disturbance of the vertically acting muscles.

There can be no doubt that abnormal power of one or more muscles may be present, but it seems probable that any inherent abnormality in the power of the muscles would be congenital, and as such would be likely to give rise to a manifest squint at a time when the tendency toward single binocular vision is absent or very weak. One can well wonder whether this abnormal power is not due, in heterophorias, to unconscious exercise or excessive innervation of the muscles concerned, rather than to any inherent abnormality of these muscles. In the same way variations in the length of the tendons or in the position of their insertion would have similar effects and are therefore best ignored as causes of heterophorias. Gould [5] believed that the cause lies in innervational abnormalism rather than in such variations in muscle insertions and lengths.

This brings me to a consideration of the fifth cause of heterophorias, errors of refraction. There can be no doubt that such errors may be factors in the production of phorias. Worth [6] said that "the term, heterophoria, should be reserved for cases in which the anomaly persists after optical correction of any refractive error which may be present." Savage,[7] however, pointed out that "there is no direct connection between the brain center for the ciliary muscles and those centers controlling the muscles which elevate and depress the eyes." Hyperphoria, according to this author, is intrinsic, that is, not usually affected by errors of refraction or their correction. Zentmayer,[8] in support of this, found less than 1 per cent of his cases of hyperphoria altered by the correction of the ametropia.

The sixth possible factor in producing heterophoria, according to Wells' list, is the fusion faculty. This may be defined as "that faculty by which the movements of each eye are so regulated that single binocular vision results." Innervational control by this fusion sense aims at the proper functioning of each set of muscles of the eyes. It may therefore be said to aid in hiding heterophoria. In fact, as noted, practically

5. Gould, G.: Innervational Abnormalism the Cause of Heterophoria, Ann. Ophth. & Otol. **3**:35, 1894.

6. Worth, C.: Squint, ed. 5, Philadelphia, P. Blakiston's Son & Company, 1921, p. 170.

7. Savage, G. C.: Ophthalmic Myology, Nashville, Tenn., Gospel Advocate Publishing Company, 1902, p. 254.

8. Zentmayer, W.: A Study of the Effect on Heterophoria of the Correction of Ametropia, J. A. M. A. **63**:572 (Aug. 15) 1914.

all tests devised for measuring the phorias act by virtue of a more or less complete suspension of the fusion sense. Incomplete development of the fusion sense would tend to act in this way; that is, it would make manifest, and not produce, a phoria. That to which I refer as the fusion sense is the resultant of at least two forces: (1) the effort required to produce single binocular vision, and (2) the amount of effort capable of being put forth. Both of these forces are variable to a large degree. In infancy, the fusion habit is formed if the effort required to produce single vision is relatively small or if the effort capable of being put forth is relatively large. Even when well developed, the "breadth" of fusion is subject to variations, such as the patient's general health (reserve power), the time of day, etc. But it is only rarely that the fusion faculty produces a phoria by innervating too strongly a muscle or group of muscles. In such a case the muscle spasm (which it really is) is due to a strong fusion faculty, not to an underdeveloped one.

It seems most probable that as far as the vertical phorias are concerned, innervational abnormalism and malformation of the cranium and the orbit are the major causes. Since, however, the treatment is chiefly through, or is directed at, the muscles regardless of the cause, the important matter is the measurement of the phoria.

If a test can be found that is dependable and that can be used at least as effectively as the Maddox rod test and under conditions as nearly normal as possible, that is, without suspension of the fusion sense, it seems that this would be a step forward. It may be possible with such a test to present additional data on the relation between phorias and the severity of their symptoms. The test to be presented is divided into two parts. The first is a step in which any abnormal condition of the ductions is made apparent and its relation to the phorias determined. It is carried on without suspension of the fusion sense. The second step may be referred to as a "fatigue" test. This is a Maddox rod test done after the first test and acts as a check on the first and as a further aid in studying the relations between the phorias and the ductions. This test could probably more correctly be called the Maddox rod test under innervational equilibrium.

Before going on with a description of the tests it may be well to define some of the terms used in this presentation. The term heterophorias as here used refers to a turning away of one or both visual lines from the point of fixation when the fusion sense is suspended; it cannot be noted by the examiner when the fusion center is active. Torsional variations would not be included in this definition as cyclophorias are concerned with inclination of planes and meridians, and not with visual axes. To include these would complicate the definition,

and such inclusion is unnecessary, because tortional disturbances were not present in any of the cases considered and are not to be studied here. Esophoria may be defined as a tendency of the two visual lines to become more convergent than is required for binocular fixation. Exophoria, then, is a tendency of the two visual lines to be less convergent or more divergent than required for binocular fixation. Hyperphoria is a tendency of the eyes so to rotate that one visual axis lies in a higher plane than the other. It is not necessary that both eyes rotate, and it is not intended that one commit himself to an opinion as to which visual axis is higher or lower than it should be. As Howe [9] pointed out, the abnormally contracting muscle cannot be determined, and it is therefore unnecessary (Stevens [10]) to use the opposite term, hypophoria. Simply stated, the condition of right (left) hyperphoria is one in which there is a tendency of the right (left) visual axis to lie in a plane above the other.

The terms cyclophoria, anaphoria and cataphoria are not involved in the scope of this article. Orthophoria is said to be present if all tests for heterophorias give negative results, and it can be defined as the condition of perfect muscle balance at distance and near. By duction is meant the maximum available power of a muscle or group of muscles to maintain single binocular vision despite increased demand. Abduction refers to the power of the abductors (external recti) to maintain single binocular vision; it is measured by means of prism with its base in, before either or both eyes, and is equal in prism diopters to that amount, any increase of which results in diplopia. Adduction is the similar power of the internal recti measured by prisms base out. Right sursumduction is the power of the right eye alone to turn up, or the left eye alone to turn down, or both eyes to turn together (right eye up and left eye down) and is measured by prism base down before the right eye or base up before the left eye. Left sursumduction is the power of the left eye alone to turn up or the right eye alone to turn down, or both eyes to turn together (left eye up and right eye down) and is measured by prism base down before the left eye or base up before the right eye. It is to be emphasized here that right sursumduction and right hyperphoria can both be measured by prism base down before the right eye; in measuring ductions the fusion center is as active as it is possible for the patient to make it at the moment, while in measuring phorias the fusion is in as inactive a state as it is possible for the test

9. Howe, L.: Muscles of the Eye, New York, G. P. Putnam's Sons, 1908, vol. 2, p. 100.

10. Stevens, G. T.: Motor Apparatus of the Eye, Philadelphia, F. A. Davis Company, 1906, p. 292.

to produce, so that phorias are made manifest and are then measurable by prisms.

It seems unnecessary to go into detail in describing all the variations of the tests devised for measuring phorias. These can be found by reference to the various textbooks on this subject. It will suffice here to state again that in practically all subjective tests for heterophoria the principle has been to suspend the control of the fusion center. The Maddox rod test has been the one adopted for comparison in this study, as it is simple and widely used. In testing for vertical phorias it has less disadvantages and more advantages than other suspension tests. When applied to testing for horizontal phorias, the Maddox rod test is practically as good as the others. The Maddox rod screen test (Dolman [11]) has no material advantage over the simple Maddox rod test and contains an objectionable element, which is even more true of the occlusion test (Marlow [12]). This element is the fact that the effects of the reflex started by the occlusion of one eye are not entirely counteracted before the test is applied. This will be more fully considered in a separate paper.

The test to be described, as already briefly referred to, is divided into two parts. In the first part the duction test is continued to the point of establishment of equilibrium of innervation, evidenced by the ability to get consistent and constant readings. In the second part a Maddox rod test is made after production of this presumed innervational equilibrium. In its present application the test is limited to the vertical meridian.

It is not intended to make a plea for the study and correction of small degrees of hyperphoria, but it seems natural to assume, purely on the basis of supply and demand, that smaller deviations in the vertical meridian deserve attention more than similar or even larger abnormalities in the horizontal meridian or even in abnormalities of declination (cyclophorias). Most authors have come to a fair agreement that there is little difference between the amount of prism that can normally be overcome base up or base down before either eye. According to Worth,[13] the normal limits of duction are between 1.5 and 2.5 prism diopters base up and down.[14]

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11. Dolman, P.: Maddox Rod Screen Test, Tr. Am. Ophth. Soc. **17**:235, 1919.

12. Marlow, F. W.: Prolonged Occlusion Test, Am. J. Ophth. **10**:567, 1927.

13. Worth, C.: Squint, ed. 6, Philadelphia, P. Blakiston's Son & Company, 1921, p. 183.

14. Whenever prisms are referred to in this article, prism diopters (△) are indicated. Since 1895, most authors have been using prism diopters in their work, although not always specifically stating that they have done so. In fact, many have carelessly used the term "prism degree" for "prism diopters."

Savage [15] stated that the average is 3 prism diopters base up and down. Peter [16] gave the normal average supraducting power as from 2 to 3 prism diopters and considered these as rather constant values. There is no developmental or functional reason for presuming unequal vertical ductions in the normal. There is no call for having one visual line in a higher plane than the other with the head held erect. Early in life the same horizontal plane is established for each eye. Worth [17] and Peter,[18] among others, stated that the eyes show good vertical balance at birth. It is no doubt true that, studied symptomatically, hyperphorias are found to produce more serious complaints than other forms of heterophoria. Most authors are definite in stating that hyperphoria is the most important phoria to be considered.

From a purely physical point of view, if the ductions are equal up and down, the point of equilibrium may be assumed to be at zero. When the duction tests in the vertical meridian are irregular, that is, when the vertical ductions are unequal, the patient may be considered to have a latent hyperphoria (Stevens [19] and Hansell and Bell [20]). Worth [21] referred to bringing "the eye to the middle range of the prism duction." Should one find, for example, that the right eye overcomes 4 prism diopters base up and only 2 prism diopters base down, the point of equilibrium must be considered at a point indicated by 1 prism diopter base up. This would then mean equal ductions (3 prism diopters base up and down), (chart 1 *b*). The difference between the first two duction readings, however, is 2. Thus such a point of equilibrium lies halfway between the two readings, nearer the larger reading, and is easily found by dividing the difference by 2. In the example given it would be $\frac{\text{B. U.} - \text{B. D.}}{2} = \text{A}$, in which A is the amount of prism needed to create the new center of equilibrium, B.U. the maximum amount of prism base up overcome, B.D. that prism base down overcome. On substituting the values in the example the result is $\frac{4 - 2}{2} = \text{A} = 1$, and since the larger reading is base up, the final prism is 1 prism diopter base up. The error is made more evident because the difference in ductions is twice the real defect. That this method can be applied to tests for vertical phoria is shown by a consideration of the results of

15. Savage, G. C.: Ophthalmic Myology, Nashville, Tenn., Gospel Advocate Publishing Company, 1902, p. 84.

16. Peter (footnote 4, p. 99).

17. Worth (footnote 6, p. 21).

18. Peter (footnote 4, p. 220).

19. Stevens, G. T.: Motor Apparatus of the Eyes, Philadelphia, F. A. Davis Company, 1906, p. 281.

20. Hansell and Bell: Equilibrium of the Ocular Muscles, Ann. Ophth. & Otol. **1**:148, 1892.

21. Worth (footnote 6, p. 191).

the duction test in (1) cases of vertical orthophoria (cases showing no hyperphoria by the Maddox rod tests before and after application of the duction test) and (2) in cases of hyperphoria (table).

It can be seen that in vertical orthophoria (table) all the readings checked to within 0.5 prism diopter. The group of 80 cases of hyperphoria was made up by combining the 46 cases in this series in which both tests were done with 34 cases of hyperphoria chosen consecutively from a list of 300. Of these 80 cases it will be noted that 93.75 per cent checked to within 0.5 prism diopter. Of the total of 195 cases in these two groups, all but 5, or 97.43 per cent, checked to within 0.5 prism diopter, and 92.3 per cent to within 0.25 prism diopter. In the first group of 115 cases of vertical orthophoria the averages of the modified duction readings were 1.73 prism diopters base down before the right eye and 1.75 prism diopters base up before this eye, giving

Comparison of the Modified Duction Test and the Maddox Rod Test No. 2

	Orthophoria		Hyperphoria		Total	
The Two Tests Checked	No. of Cases	Per Cent	No. of Cases	Per Cent	No. of Cases	Per Cent
Exactly	105	91.11	39	48.75	144	73.84
To within 0.125 prism diopters	1	0.87	6	7.50	7	3.59
To within 0.25 prism diopters	6	5.22	23	28.75	29	14.87
To within 0.50 prism diopters	3	2.80	7	8.75	10	5.13
To within 0.625 prism diopters	0	0	1	1.25		
To within 0.75 prism diopters	0	0	2	2.50	5	2.57
To within 0.875 prism diopters	0	0	1	1.25		
To within 1.00 prism diopters	0	0	1	1.25		
Total	115		80		195	

a mean variation in percentage of 0.57. In none of the five cases in which the results of the modified duction test and the Maddox rod test no. 2 varied by more than 0.5 prism diopter was the reading greater by the Maddox rod test. There seems to be little danger of getting larger readings by this method of using the Maddox rod than the ductions justify.

That this method is not entirely new was learned only after it had been in use for almost two years. A reference to what was called the "Doak test" [22] was then seen in the literature. This test is based on the suspension of the fusion sense and is not, therefore, similar to the test being presented. It does, however, have one point in common, namely, the doubling of the error. In the Doak test the fusion is suspended by a single prism, one of the two images is doubled by a double prism, making three images, and the relation of one image to the doubled image is studied by means of a rotary prism. For example, a prism,

22. Doak, quoted by Savage, G. C.: Ophthalmic Myology, Nashville, Tenn., Gospel Advocate Publishing Company, 1902, p. 269.

base in, is placed before the right eye sufficiently strong, say 8 prism diopters, to produce horizontal homonymous diplopia. A (6 diopter) double prism (bases together) is placed below the left eye with its axis vertical so that the left eye sees two images separated vertically. These images are now seen, two in a vertical line by the left eye and the third to the right of this line by the right eye. If this third image (*C*) is nearer the upper image (*A*), left hyperphoria is present, and if it is nearer the lower image (*B*), right hyperphoria is present. If a Risley rotary prism is now placed before the right eye and rotated base down,

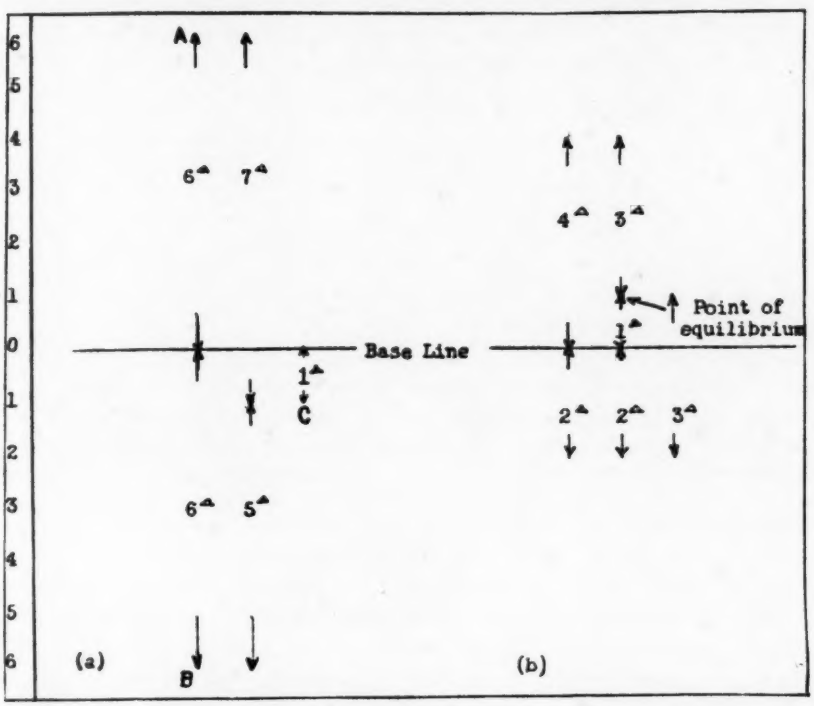

Chart 1.—*a*, the doubling effect in Doak's test; *b*, the point of equilibrium.

the amount of prism which brings the image *C* in line with the upper image *A* is a measure of the separation between these two images. Similarly, the amount of prism which brings this same image (*C*) in line with the lower image (*B*) measures the separation between these two images. The total (*CA* and *CB*) equals 12. If *CA* equals 7 and *CB* equals 5, it is evident that the image *C* was nearer the lower image *B* and required less prism for alignment with it. If the readings were 6 and 6, it would be presumed that there was no hyperphoria. If *C* were 1 unit (1 prism diopter) nearer the lower image, the reading *CB* would be 5, while the reading *CA* would be 7; the difference in the readings would be 2, or twice the real defect (chart 1 *a*).

As stated, this doubling of the error in the Doak test is similar to that which occurs in the new duction-phoria test to be described.

AUTHOR'S METHOD

1. The patient is seated approximately 20 feet from a spot of light about five eighths of an inch in diameter. The head is held erect, and the eyes are maintained in the primary position. The DeZeng phorometer [23] is used, which has on each side a Risley rotary prism of 30 prism diopters' capacity, a white multiple Maddox rod and cells for the patient's corrections. The pupillary distance and spirit level are adjusted for each patient.

2. One of the Maddox rods is placed before one eye and the rotary prism before the other eye, so that the prism may be introduced base up or base down.

3. The room is darkened,[24] only the spot of light at a distance being left. The Maddox rod is turned so that the patient sees a horizontal streak of light in addition to the spot of light.

4. The patient is asked to state whether the streak is above, below or through the center of the spot of light. If above or below, the prism is rotated until the streak passes through the center of the light.[25] The light is turned on and the reading taken. If desired, before the light is turned on, the streak may be rotated to the 90 degree meridian and the horizontal deviation measured by prism base in or out, the second Risley prism having been left at the beginning before the other eye with its zero mark at 90 degrees.

5. The rod is removed from before the eye and the light again turned off. The patient should now see one spot (single binocular vision). The prism with its zero mark at 180 degrees is now slowly rotated upward and downward, the patient counting the images and saying "two-one-two-one," etc., until this has been done a minimum of three times in each direction. This is usually sufficient. The important factor is the stopping point. After the described rotations, one further rotation is continued through the patient's "one," and is stopped the moment the patient next says "two." Again the darkness, though not absolutely necessary, is a factor minimizing the personal equation. If the last direction of rotation has been down, the reading is recorded as so much prism base down overcome by the eye behind the prism.

6. Step 5 is repeated, entirely, the examiner stopping this time to take the reading when the prism is being rotated upward, on the patient's last "two." There is usually no material difference in the results if in step 5 the rotations each way are repeated three or more times, or if there is a slight inequality in the number of turns up and down. Steps 5 and 6 give the readings in the test hereinafter referred to as the modified duction test. These two steps may be combined if no appreciable

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23. Manufactured by the American Optical Company, Rochester, N. Y. The instrument is now called the "Wellsworth" phorometer.

24. There is no material difference in the results if the room is fairly well lighted, but many patients have difficulty seeing only one streak under these conditions. Then, too, working in the dark results in readings less influenced by the examiner's opinions. In my experience it is rarely difficult for a patient to see both the streak and the spot with the room darkened. When difficulty is present, it seems to be due rather to an improper adjustment of the apparatus.

25. Occasionally, a horizontal prism may be needed to bring the streak and light together.

delay occurs in taking the reading at the end of step 5. This can be done only if a faint but sufficient light enables the examiner to take readings at will without stopping the test.

7. Again step 5 is repeated, but this time the stop is made when the patient says "one" after the required number of rotations have been made. Then, before the light is turned on, the Maddox rod is placed before either eye so that the horizontal streak is again seen, and the prism rotated sufficiently to bring the line through this light and the reading in prism diopters noted. It is important not to make any change in the lighting arrangement before the Maddox rod is placed before an eye and the prism rotated as necessary.

Summarizing, there are finally four readings; one, that obtained in step 4 with the Maddox rod before ductions were taken; two and three, the readings obtained by steps 5 and 6—the ductions, and four, the last reading with the Maddock rod and prism with the muscles in so-called innervational equilibrium (step 7). This application of the Maddox rod test in the following is referred to as the Maddox rod test no 2. Its value is seen in the fact that frequently reading number one is zero while the computations from readings two and three and reading four snow definite hyperphoria. Equally frequent is the finding of a greater amount of hyperphoria by this modified duction test and the Maddox rod test no. 2; indeed it is sometimes two and three times the first reading. On the other hand, duction tests as ordinarily done often show readings higher by 1 prism diopter than that obtained by the method described. In fact, it depends very much on which way the prism is first rotated as to which will be the higher of the two readings as usually taken. Marlow[26] gave data that seem irregular. In one instance (case 6824) he presented a patient with "3 prism diopter left hyperphoria"; yet the maximum the patient overcame by the ordinary duction method was 3 prism diopters base down before the left eye. Certainly one would expect to find that the patient with single binocular vision overcame more prism base down left eye than 3 prism diopters when this was just equal to the left hyperphoria. Such irregularities are never found in the foregoing "modified duction tests" (steps 5 and 6).

RESULTS

In the choice of patients for this report, a good history was considered important; for instance, one cannot depend simply on a patient's statement that he had no headache, because frequently the patient replies in the negative, but if asked more specifically, "No sick headache, no headaches of any kind?", the answer is, "Oh, yes, but not caused by my eyes." The hyperphoric patient frequently is not conscious of any trouble with the eyes. It is this type of patient who often gives a history that makes one suspicious of anomalies of the muscles, and when checked up a large percentage show them.

It became evident that a certain list of conditions could be drawn up which, *a priori,* should lead one to suspect muscular trouble. Any patient presenting one (or two) of these should be considered unsatisfactory for use as a normal person. This series contains only cases in which the complaints did not indicate, *a priori,* that the patients were

26. Marlow, F. W.: Prolonged Occlusion Test, Am. J. Ophth. **10**:567, 1927.

suffering from an anomaly of the extrinsic muscles. The following is a list of conditions, any one of which was considered sufficient, if present, to disqualify the patient from inclusion in this series, even though subsequent tests of the muscles showed no imbalance: (1) migraine, (2) epilepsy, (3) manifest squint, (4) encephalitis, (5) Parkinson's disease, (6) chorea, (7) neurasthenia, (8) functional neurosis, (9) torticollis, (10) labyrinth disease, (11) diplopia, (12) prism in old glasses, (13) cerebral arteriosclerosis, (14) fainting spells and (15) operations on the muscles. These cases either belong to a larger group under innervational abnormalism or are frankly related to muscular imbalances.

Authorities differ as to the type of headaches found in hyperphoria. Peter [27] said that as a rule the headache is increased by close work, and that a night's rest brings relief. Savage,[28] however, said that headaches that come on unassociated with near work, if due to the eyes, are usually heterophoric and not refractive. It has been the experience in this study to find that the great majority of patients with hyperphoria have headaches unassociated with near use of the eyes. Nothing is present, however, to prevent a patient with hyperphoria from having sufficient ametropia to cause increased trouble with near work. In such cases the patient frequently has two types of headaches.

The following is a second list of conditions, any two of which were considered sufficient to disqualify the patient from inclusion in this series, even though the subsequent tests on the muscles showed no imbalance: (1) headaches not associated with near use, (2) nausea with or without vomiting, (3) dizziness, (4) vertigo, (5) pains in the neck, (6) blurring of vision periodically or scintillating scotoma and (7) poor vision, 0.6 or less.

The following is a list of chief complaints or diagnoses which were present among the group considered from their histories to be free from any suggestion of a muscular anomaly: (1) eyes tire at near work, (2) headaches after use of the eyes for near work, (3) headaches in afternoon or evening, (4) aching of the eye, (5) drowsiness, (6) sensitiveness to light, (7) foreign bodies on either cornea, (8) gastric distress, (9) loss of place in reading, (10) dizziness, (11) chalazion, (12) trachoma, (13) nervousness, (14) vasomotor rhinitis, (15) general fatigue, (16) chronic colitis, (17) psychopathic personality, (18) neuralgia, (19) near-sightedness, (20) keratitis superficialis, (21) xanthelasma and (22) pterygium.

Of about 600 cases reviewed, 192 were found acceptable. In the latter group the great majority of patients had complaints of the eyes

27. Peter (footnote 4, p. 121).
28. Savage (footnote 15, p. 114).

brought on or aggravated by near use of the eyes. The percentage of muscular anomalies would probably be even less than that found were a group obtained in which there were truly no complaints of the eyes. Such a group would be extremely difficult to obtain in any large city in this industrial age.

As far as possible, the refraction was tested in all cases under atropine with the retinoscope. Usually each eye was refracted separately following the method which is standard in the University of Chicago Clinic.[29] Of the total number (192), 2 had no refraction test, 5 had manifest refractions and 29 had homatropine refractions. In practically all cases the maximum refractive observations, fullest in hyperopia and minimal in myopia, were prescribed. Tests of the muscles were made on an average of from two to three times in each case, usually once before refractions and at least once after the correction for the ametropia had been worn for one month or more. In many cases the tests for phoria were done with one or both eyes under atropine. There were no material changes in the hyperphoria that could be considered as resulting from the ametropia or from the correction of it. This agrees with the statement of Zentmayer, who, as stated, found less than 1 per cent of hyperphoria affected by correction of ametropia. Further, as seen from a study of chart 2, there was no relationship between the amount of hyperphoria and the amount of ametropia. This is in line with the observation by Savage, given earlier, that there is no connection between the centers for the ciliary muscles and those controlling the elevators and depressors.

It will be noted in the list of causes for noninclusion in this series that poor vision is given. There are two reasons for this. 1. Patients with poor distance vision are less likely to note any trouble due to the presence of hyperphoria. In this group imbalance of the muscles is not so frequently a cause of complaint, as the blurred, enlarged images permit moderate degrees of overlapping or separation to exist without subjective symptoms. The histories are therefore less reliable. That both eyes function for better vision only when sufficient vision exists in each eye was noted by Walter.[30] 2. In making the tests, clear definition of the images is desired. This is particularly true in the duction tests. Patients who see large, blurred images will less quickly and less easily see double, so that their ductions are often found to be four and even six times greater than those that are usually found; the same patients, with proper corrections for their ametropia, later show ductions in keeping with the others. The cases in which the vision

29. The clinic is under the direction of Dr. E. V. L. Brown.

30. Walter, W.: Heterophoria and Heterotropia, Am. J. Ophth. **3**:201, 1902.

became improved to better than 0.6 were not excluded from this series, because of poor vision, and the tests were made with the correction in the phorometer. Apropos of this, it may be stated that in cases with no material difference in the vision, no difference was found in the hyperphoria, whether tested for with or without the correcting lenses in the phorometer. However, there were few eyes with even this poor (corrected) vision in the series. Only one eye had corrected vision

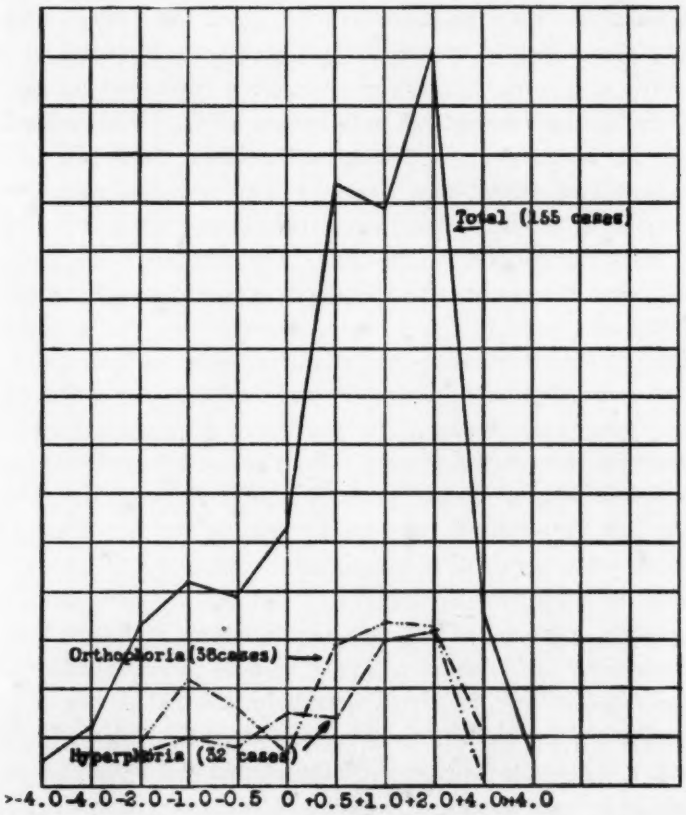

Chart 2.—Frequency curves of refraction (atropine) in orthophoria and hyperphoria.

of but 0.6; 1, 0.6 + 3, and 1, 0.8 — 3; 8 pairs of eyes had corrected vision between 0.8 — 3 and 1.0 + 3. All the other eyes, or 365 of 384, had corrected vision ranging from 1.2 — 4 to 2.0 — 1, as tested at 20 feet.

The results of the usual Maddox rod test indicated that of the 192 cases, 32, or 16.67 per cent, showed hyperphoria of at least 0.5 prism diopter, and only 9, or 4.69 per cent, showed more than 0.5 prism diopter of hyperphoria. These results compare favorably with the observations

of Hansell and Reber [31] and those of Howe and Williams.[31] The former, in 700 cases, found that 20 per cent showed at least 0.5 prism diopter of hyperphoria and only 7 per cent of 3,600 cases showed at least 1 prism diopter. The latter reported the incidence of hyperphoria as 16 per cent, agreeing almost exactly with my figures, and showing, too, that ordinary care was probably exercised in doing the common Maddox rod test. Peter,[32] Carpenter,[31] Macklin [33] and Field [34] gave figures for the incidence of hyperphoria ranging from 33 to 52 per cent in the order named. Bielschowsky,[35] Bannister,[36] Burnett,[37] Dolman [38] and Posey [39] gave much lower figures, ranging from only 5 (Bielschowsky) to 13 per cent (Posey). It is probable that the difference may have been due to the choice of cases. Even when tested for by the modified tests herein presented, which gave maximum observations, I found that only 55, or 28.65 per cent, of the 192 cases showed 0.5 prism diopter or more of hyperphoria.

In the 192 cases here studied primarily for hyperphoria, orthophoria was found in 51 cases, esophoria in 73 cases and exophoria in 59 cases. Indeed, there were only 8 cases of hyperphoria unassociated with horizontal imbalance, but the classification of cases in groups such as hyperesophoria and hyperexophoria, in my opinion, complicates a consideration of hyperphoria as such. For this reason this was not done. The foregoing figures show that orthophoria was present in 26.5 per cent, esophoria in 38 per cent and exophoria in 30.7 per cent. These figures for exophoria and esophoria agree closely with those of Macklin [40] and others.

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31. Quoted by Peter, L. C.: Extra-Ocular Muscles, Philadelphia, Lea & Febiger, 1927, p. 119.

32. Peter (footnote 4, p. 119).

33. Macklin, W. F.: Prevalence of Heterophoria, M. Clin. North America **4**:337, 1920.

34. Field, P. C.: Phorometry of Normal Eyes, Arch. Ophth. **40**:526, 1911.

35. Bielschowsky, A.: Ueber die relative Ruhelage der Augen, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **39**:67, 1913.

36. Bannister, J. M.: Hints in Relation to the Dynamics of the Extrinsic Muscles, Am. J. Ophth. **3**:878, 1920.

37. Burnett, S. M.: Heterophoria and Its Relation to Asthenopia, Tr. Am. Ophth. Soc. **6**:217, 1891.

38. Dolman, P.: Relation of the Sighting Eye to the Measurements of Heterophoria, Am. J. Ophth. **3**:258, 1920.

39. Posey, W. C.: Study of Two Hundred and Eighty-Seven Cases of Hyperphoria, Ophth. Rev. **17**:372, 1898.

40. Macklin, W. F.: Prevalence of Heterophoria, M. Clin. North America **4**:337, 1920.

SUMMARY

1. The combination of the modified duction and the Maddox rod test as herein described is new. This modified duction test gives consistent readings. The readings are useful in obtaining the vertical phoria present and are closely related to the amount of the vertical phoria, especially as determined by the modified Maddox rod test.

2. Muscular equilibrium, at least as far as the vertically acting muscles are concerned, should be computed from the center of the duction equilibrium as the zero mark.

3. In 192 cases considered to be clinically free from any suggestion of muscular imbalance, hyperphoria was the least common and esophoria the most common imbalance.

SYMPATHETIC OPHTHALMIA

UNASSOCIATED WITH PERFORATION OR RUPTURE OF EYEBALL *

JAMES H. DELANEY, M.D.
ERIE, PA.

Cases of sympathetic ophthalmia, as every ophthalmologist knows, are not a rarity. One is immediately on the lookout for this disorder in case of injury to the eye in which there has been either a perforation of the eyeball (operative cases included) or a rupture of the tunics of the eye. This is especially true when the opening involves the ciliary region, or so-called danger zone.

Does the average ophthalmologist look for this condition when there has been no perforation or rupture of the eyeball? Does he even consider this possibility when he is confronted with an ocular injury caused by a blow from a fist or even as innocent an object as a snowball?

A careful search of the literature fails to show undisputed cases arising without perforation or rupture of the eyeball (cases of melanosarcoma excepted). Jackson [1] stated: "The occurrence of true sympathetic ophthalmia without traumatic rupture or perforation of the coats of the eye, and the method of its production are still uncertain"; while Butler [2] went so far as to say, "We know that the disease follows a perforating wound of the eye, and that with the single exception of its sequence to certain intra-ocular tumors, it is not associated with any other type of injury or ocular disease."

In view of this generally accepted opinion, this case of sympathetic ophthalmia caused by a blow from a snowball with no resulting injury to the cornea or any perforation or rupture of the eyeball should be of exceptional interest.

REPORT OF CASE

History.—E. C., aged 9 years, was first seen on Nov. 29, 1929. He was referred by a school physician and said that on November 23 he was struck on the right eye with an icy snowball. He did not tell his parents about the accident, and received no attention until November 29. The vision was 20/20 in both eyes. The right eye showed marked ciliary injection, with no staining of the cornea with fluorescein and no evidence of any perforation or rupture of the eyeball. A marked degree of traumatic uveitis was present, with posterior synechia already formed. There were some cells floating in the anterior chamber; the media were slightly hazy, but no abnormality was noted in the fundus. Examination showed

* Submitted for publication, Dec. 6, 1930.

1. Jackson, E.: Am. J. Ophth. **9**:631, 1926.
2. Butler, T. H.: Tr. Ophth. Soc. U. Kingdom **48**:346, 1928.

the left eye to be entirely normal. Atropine, 2 per cent, was instilled into the conjunctival sac, and a subconjunctival injection of epinephrine failed to free entirely the synechia which had formed. While there was no external evidence of perforation of the eyeball, a roentgenogram was taken to rule out any possibility of a foreign body. This was reported negative. The patient was under continuous treatment until Jan. 11, 1930, at which time the eye was entirely quiet, with vision of 20/30. The only sequelae of the inflammation were some posterior synechia, which I had never succeeded in freeing. On this date the patient was discharged with the warning that further trouble might arise in this eye, owing to the synechia present.

The patient was not seen again until Aug. 15, 1930, when he was brought to the office with a history that for the past four days the right eye (the affected eye) had been red and had given him severe pain. He did not complain of any disorder of the left eye.

Examination and Course.—At this time vision in the right eye was limited to light perception only, and in the left eye it was 20/50. Examination of the right eye now showed marked pericorneal and ciliary injection with photophobia, so that the eye was constantly kept closed. The cornea was steamy with deposits on the posterior surface. The iris was degenerated with the formation of new vessels, and there was an iris bombé with complete seclusion of the pupil. A deeper view of the eye was not possible. With the slit-lamp, many cells could be seen floating in the anterior chamber. The tension was elevated by palpation. The diagnosis of the condition in this eye was a recurrent uveitis with secondary glaucoma.

Examination of the left eye showed some pericorneal injection, some fine deposits on the posterior surface of the cornea with a few cells floating in the anterior chamber. The iris was congested, and there was a dense posterior synechia below from 9 around to 3 o'clock, with a fibrin-like exudate on the border of the iris. There were a few fine vitreous opacities and the margins of the disk were hazy. Tension was normal. Examination of this eye led to a diagnosis of sympathetic ophthalmia.

The patient was immediately sent to the hospital, and the right eye was enucleated. Major George Callender of the Army Medical Museum gave the following report on the enucleated eye: The cornea was intact. There was iris bombé with a delicate pigmented membrane blocking the pupil, and rather dense scarring of a thinned iris with a broad peripheral anterior synechia. Nodular infiltration of the lymphocytes was seen near the area of the pupil. The lens was partially dislocated forward, with partial rupture of the suspensory ligament and atrophy of the ciliary processes. Some of the ganglion cells in the retina were degenerated, and there was some glial proliferation. There was some perivascular lymphocytic infiltration in the choroid, which, however, was not extensive enough to be designated as sympathetic disease. The central vein was markedly dilated, as were the capillaries of the nerve. The lamina cribrosa was moderately depressed, and there was some edema at the macula.

The following diagnosis was made: trauma, partial dislocation of the lens, secondary iritis, secondary glaucoma, recurrent secondary uveitis.

Intensive treatment was instituted, consisting of intramuscular injections of nonspecific foreign protein, inunctions of mercury, heavy doses of salicylates, atropine, dionin and hot compresses locally. Under this treatment the sympathizing eye quieted, but the synechia failed to break loose. The patient has been under constant observation since and has had no flare-ups; examination shows vision of 20/30, corrected to 20/20 with a sphere +0.75 cylinder +0.75 axis 75 degrees.

To rule out the possibility that the inflammation in the left eye was merely coincidental, the patient was examined for any other possible cause of a uveitis. The Wassermann test of the blood and the Pirquet test gave negative results; examinations of the nose and sinuses, including roentgenograms, gave negative results, and the patient's tonsils had been removed. A general physical examination gave negative results, and a dentist reported no infection of the teeth.

CONCLUSION

Contrary to the generally accepted opinion and in opposition to certain theories as to the pathogenesis, I concluded that this was an indisputable case of sympathetic ophthalmia without the usual perforation or rupture of the eyeball. I feel that the possibility of such a development should be borne in mind in all cases of traumatic uveitis, even when there has been no opening of the tunics of the eye.

RETINAL DETACHMENT

A REVIEW OF SOME RECENT LITERATURE *

E. C. ELLETT, M.D.
MEMPHIS, TENN.

The surgical treatment for retinal detachment has been the subject of a number of recent papers, and several of these, which have not been so generally quoted or referred to, have presented the question from what might be called the two points of view now most discussed, so that it might be worth while to review briefly some of these contributions, especially those of Gonin [1] (Lausanne, Switzerland), Sourdille [2] (Nantes), Finlay [3] (Havana) and Badeaux [4] (Montreal), since they come from four different countries.

The great interest in this subject at present is undoubtedly due to Gonin's contributions, which, to quote Sourdille, have been made "with an abundance of extraordinary means, in journals of all languages and in communications to societies of all countries." The remarkable number of cures, up to 50 or 60 per cent, reported as the result of this operation, in a disease that heretofore offered hope in only 1 or 2 per cent of cases or less, has attracted wide attention. His earlier papers are not considered in this review, since they contain nothing different from the ones to be quoted, nor is the last contribution to the Oxford Congress in July, 1930, found to contain new matter, except as will be mentioned. Sourdille's [5] long paper published in 1923 contains nothing not covered in the one previously referred to.[2]

Gonin's article [6] introduces the subject and is to be followed by a later report giving operative details and indications. He explains his theory that the cause of detachment is the passage of the fluid of the vitreous through a retinal tear and its dissection of the retina from its pigmentary layer. All of this material has been given in his other

* Submitted for publication, Jan. 29, 1931.

1. Gonin, J.: Remarks and Comments on Two Hundred and Forty Cases of Retinal Detachment Treated for the Most Part by Operation, Ann. d'ocul. **167**:361 (May) 1930; The Treatment of Detached Retina by Searing the Retinal Tears, Arch. Ophth. **4**:622 (Nov.) 1930.

2. Sourdille, G.: A Note on the Pathogenesis and Treatment of Detachment of the Retina, Rev. cubana de oft., July, 1930.

3. Finlay, C. A.: A Modification of Gonin's Surgical Method of Treatment of Detachment of the Retina, Arch. Ophth. **4**:662 (Nov.) 1930.

4. Badeaux, François: Reflections on the Operative Treatment of Detachment of the Retina, Ann. d'ocul. **167**:383 (May) 1930.

5. Sourdille, G.: Arch. d'opht., July, 1923.

6. Gonin (footnote 1, first reference).

articles, of which this is a résumé. He repeats that the tears are often small and so peripherally situated as to be hard to see. No statistics of operative results or details of technic or frequency, etc., of holes are given.

There is one part of Gonin's last paper,[7] read before the Oxford Congress, that should be quoted fully, since he corrects in a footnote a misapprehension under which an English visitor (Ormond) labored as regards Gonin's idea of the way retinal detachment is caused. Ormond stated that "liquefaction of the vitreous takes place." Gonin said: "I do not think it does. I noticed only a separation of the vitreous fluid from its fibrillar mass, the latter being penetrated with epithelial cells and keeping thus a retractile strength sufficient to drag on the retina. I generally compare the retracted vitreous with a squeezed lemon, the cellular part of which has not been liquefied but simply deprived of its juice." He referred to 250 patients and 300 operations, and said that he found tears in 95 per cent of the cases, but in 10 per cent of them the hole was not in retinal tissue, but was a rupture or tearing away from its insertion at the ora serrata. In all recent cases, closing the hole cures the detachment; in older cases it improves them. Relapses and recurrences are caused by new holes or the failure to close those already present.

In 1920, Sourdille began to practice a method of treating patients with detachment of the retina based on his conception of the pathogenesis of the condition, and in 1922 he reported his results to the Academy of Medicine in Paris, the report appearing in the *Archives d'ophthalmologie*.[5] His last paper [2] is an answer to Gonin's publications and those of his colleague Amsler, and was read before the Société d'ophthalmologie of Paris in December, 1929, a translation appearing in the *Revista cubana de oftalmologia* for July, 1930. Amsler's paper describes the method of locating the holes in the retina and the curative action of the closing of these holes. Sourdille questioned the necessity of the laborious procedure of locating and closing the holes, and his paper is devoted to refuting Gonin's idea that the holes are the cause of the detachment, which is cured by closing the holes with a thermocautery.

Von Graefe first called attention to the holes, which he considered accidental. He thought that the detachment of the retina was caused by the pressure of a fluid which resulted from a "serous choroiditis." Leber evolved the "traction theory," and considered the detachment as due to the pulling on the retina by bands developed in the vitreous secondary to a disease of the vitreous. The traction of these bands tore the retina and then pulled it loose, leaving the pigmentary layer attached to the choroid. According to Sourdille, this is an error, based on the histologic examination of old cases, which showed a diseased vitreous, but one secondarily diseased. Leber was convinced of his error, and in 1908, and again in

7. Gonin (footnote 1, second reference).

1916, he attributed the holes to the retraction of newly formed preretinal membranes. He still thought that traction of some sort on the retina caused the detachment. Deutschmann based his operation of cutting bands of vitreous on this theory. Gonin adopted the same theory in the main, attributing the detachment to degeneration of the vitreous, followed by tears in the retina, due probably to chorioretinal disease of some sort which weakens the retina. Gonin claimed that the fluid of the vitreous passes through these tears and dissects the retina. Vogt, in reports to the Medical Society of Basle in 1922 and to the Swiss Society of Ophthalmology in 1923, stated, according to Sourdille, that examination with the slit-lamp does not show any bands of vitreous in retinal detachment. The reader is again referred to Gonin's statement in his Oxford Address, in which he did not claim that a degeneration of the vitreous starts the trouble. In 1925, Weekers reported to the French Society of Ophthalmology that he had been able to produce detachment experimentally in rabbits, accompanied at times by retinal holes, by superficial cauterization of the sclerotic membrane with a thermocautery, and said that as the holes are not always present they are not to be considered as indispensable to the production of detachment. In a patient given by mistake a subconjunctival injection of 1 per cent cyanide of mercury instead of a 1 : 5,000 solution, Sourdille saw a retinal detachment with a large hole corresponding to the site of the injection. He regarded the holes as only accidental, and not causal, and he said that they exist in about 10 per cent of cases, and less often in old cases. In detachments that begin above and show a hole or holes, the detachment usually gravitates below. The superior detachment cures spontaneously and the hole disappears.

Von Graefe gave a favorable prognostic significance to the holes, and developed the treatment by scleral puncture. Leber did not think that the holes could be closed, and took a pessimistic view of the possibility of curing the detachment. On clinical evidence, Sourdille expressed the belief that the detachment is due to a weakness of the adhesion between the pigmented epithelial layer and the rest of the retina, and the presence of a fluid between the two; the object of the treatment is to evacuate the fluid and excite a fresh and strong attachment between the separated retinal layers. His treatment embodies three factors: (1) evacuation of the subretinal fluid by scleral puncture, (2) provoking a sufficient reaction to seal the separated elements together, and (3) immobilization of the patient and the eye for some weeks in a favorable position.

These methods have been tried separately by von Graefe, Scholer and Samelson, without avail. Sourdille's method consists in combining them:

1. The puncture of the eye is made with a small (0.66 mm.) Graefe knife. The blade enters for at least 1 cm., which is deep enough to

penetrate the retina, and four or five punctures are made at the site of the detachment. No notice is taken of the presence or location of retinal holes. They not only are not closed, if present, but new ones are made, with the idea of drawing the subretinal fluid both ways, out under the conjunctiva and inward into the vitreous.

2. In small flat detachments a fine galvanocautery (not a thermocautery, as Gonin uses) is introduced into the eye through the scleral punctures, or they may be made with the cautery. In more extensive detachments, the scleral punctures are made with the knife and followed by a subconjunctival injection of from 1 to 2 cc. of 1:1,000 mercuric cyanide. This gives the necessary irritation over a large surface.

3. The patient is immobilized in bed, on the back for superior detachment, on the side for lateral detachments and in a half-way position for inferior detachments.

Sourdille [8] said that Gonin stoutly opposed cauterization as apt to cause contraction and a detachment on the opposite side of the eye from the cauterization; he said that he might use it when only one eye is affected, but not when the only eye is affected. In a report to the French Society of Ophthalmology, in 1928, he stated that he (Gonin) had treated fifty-nine holes with five negative and seven uncertain results. The report made at Amsterdam in 1929 was not available when Sourdille's paper was written.

Gonin claimed that the holes cause the detachment, and that closure is necessary for a cure. Sourdille claimed that when the detachment is cured the hole disappears and that he had obtained cures without closing the holes. He criticized Gonin's statements further to the effect that he (Gonin) said that he cured detachments in which the hole was presumed, but not seen, invisible or inaccessible (too far back, under a rectus muscle). Also that he cured cases with very small holes and with very large and multiple holes, which are not all closed or not entirely closed by cauterization. Sourdille also expressed the belief that the chorioretinal scars that follow the free use of the cautery are bound to cause scotoma, and by contraction can probably cause further detachment or other grave consequences. Sourdille did not hesitate to operate in old cases, some of three, four, five and six months' duration, though they are less favorable for operation than recent cases. He expressed the opinion that superior detachments are most favorable, while Gonin advised waiting till they settle and become inferior. Sourdille referred to the cases reported by Jacquau and Dor. Jacquau reported two cures in five cases, and no account was taken of the holes, i. e., Gonin's operation was not performed. Dor reported three cases, two of them being too recent to be accepted as cured. Both of these writers were enthusiastic over the Gonin operation.

8. Sourdille, G.: Ann. d'ocul., March, 1921.

Sourdille said that he had operated in 169 of about 500 cases seen in public and private practice since 1920. In 62 of these, the patients obtained enough vision to do their work. Some were cases refused by his colleagues, and in some of these the patients were cured. After six months of reattachment he does not fear a relapse.

Finlay [3] expressed the belief that there are a number of theoretical objections to Gonin's treatment, i. e., the introduction of a cautery into the vitreous through the coats of the eye, and he also feared that a permanent fistula through some or all of the tissues might follow such a procedure. He had not visited Gonin's clinic or seen any of his cases. He preferred a plan that he described, namely, evacuating the subretinal fluid by a scleral puncture, under a conjunctival flap, and allowing the retina to fall back into its place against the wall of the eye. He then superficially cauterizes the sclera near the incision, being careful not to cauterize the incision, and by this means he hopes and expects to excite an adhesive inflammation which will seal the retina back in position. He reported seven cases, with three failures, one success and three improvements. He expressed the opinion that recent cases, traumatic cases and cases in young patients offer the best prognosis.

Badeaux [4] visited the clinics of Gonin and Sourdille and was duly impressed with the earnest work of both. He expressed the belief that some cases are suitable for one operation and others for the other. In the Gonin operation he preferred the method of localization described by Amsler, by means of his "serpette," to the needle and ink plan of Gonin. He preferred a small galvanocautery at white heat to the larger thermocautery of Gonin, or the galvanocautery at "rouge sombre" of Sourdille. "If the case is recent, if I see the tear, I make an adhesion at the site of the tear or as near as I can, and for that I do a Gonin operation, which gives good results in two thirds of the cases. But I do the operation with a galvanocautery so as not to produce too large a scotoma. If the case is old or if the tear is invisible, I do a Sourdille operation. I will thus have a better chance of completely emptying the subretinal fluid, since the adhesions of connective tissue can collect it in many places."

At the clinic at Nantes, Badeaux was struck with the few traces of operation. One would almost say that the retina had not been touched. There is no localization and similar preparation, as is seen before operation at the clinic at Lausanne. The knife is plunged into the retroretinal pocket three or four times, and each puncture is followed by a subconjunctival injection of mercuric cyanide; the patient is put to bed for a month. Gonin and Sourdille have a different view of the pathogenesis and a different operative technic, but they obtain the same result, a chorioretinal adhesion.

TRANSPLANTATION OF THE HUMAN CORNEA

REPORT OF A CASE *

BEN WITT KEY, M.D.
NEW YORK

Two charity patients who are the subjects of this report came to the clinic of the New York Eye and Ear Infirmary in October, 1928. One, a man, aged 26, had had an injury two years before from a steam explosion, which had resulted in enucleation of the left eye. The right eye was retained, but with a large total symblepharon continuous with the upper fornix and extending over the upper half of the cornea (fig. 1); the entire cornea was densely opaque, no transparent corneal substance being visible; the tension was normal; vision was limited to perception of light. The other patient was a man, aged 32, with a fairly small but well defined sarcoma of the choroid in the equatorial region. The conjunctiva, cornea and iris were normal, and the vision was 20/16.

The plight of these two men could suggest only one course of procedure: an attempt at transplantation of the cornea. This was performed on Oct. 25, 1928. The Wassermann reaction of each patient was obtained before the operation and found to be negative. The blood was not typed, however, this requirement being disregarded in view of the youthful age of each patient, other things being equal and the typing of the blood a theoretical factor only. After the operation was performed, the blood of the donor was found to be type IV, and that of the recipient type II.

OPERATIVE PROCEDURE

In the blind eye, physostigmine (0.5 per cent) was instilled four times within an hour before the operation. The large symblepharon, extending from above and covering the upper half of the cornea, was dissected free and sutured well back in the upper fornix by double-armed sutures through the upper lid. A very free external canthotomy was then performed. The eye of each patient was anesthetized by deep orbital injection of a 2 per cent solution of procaine hydrochloride.

For a distance of 4 mm. completely around the cornea of the blind eye, the conjunctiva was dissected up close to the sclerotica and well up to the limbus. At the point of tangent to the upper corneal limbus, a double-armed, silk suture (no. 2) was then placed, catching up a small bit of the sclerotica, and a similar suture was placed in the sclerotica at the lower limbus. These were allowed to remain thus, to be inserted later through the graft. The dissected conjunctiva

* Submitted for publication, Dec. 6, 1930.

* Read before the American Ophthalmological Society, Hot Springs, Va., June 2, 1930.

Fig. 1.—The blind eye, showing total symblepharon; the entire cornea is densely opaque.

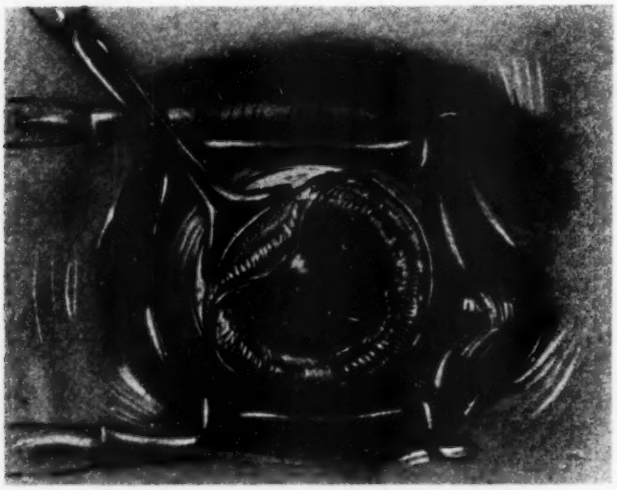

Fig. 2.—Method of removing cornea by large keratome incision introduced temporally and supplemented by cataract knife laterally.

was folded back in position and no solution of any kind was used for irrigation; the lids were held closed by a hot gauze pad.

The eye of the donor was then treated in the same manner as to conjunctival dissection. The cornea was severed at the limbus by a large keratome introduced temporally and the incision supplemented by use of the cataract knife, in order to secure a slanting flat surface to the transplant (fig. 2). This incision was thus carried downward almost to the lower tangent to the limbus. The cataract knife was then introduced below, at the nasal side near the lower tangent to the limbus. and carefully carried upward, the sclerotica being grasped with forceps as a fulcrum against the resistance of the cutting knife. This incision was completed about 2 mm. short of the upper limbus, which allowed the cornea to remain intact with the sclerotica by two small attachments, one at the upper and one at the lower limbus. The conjunctiva was then folded back in its usual position, and the lids held closed by a hot gauze pad.

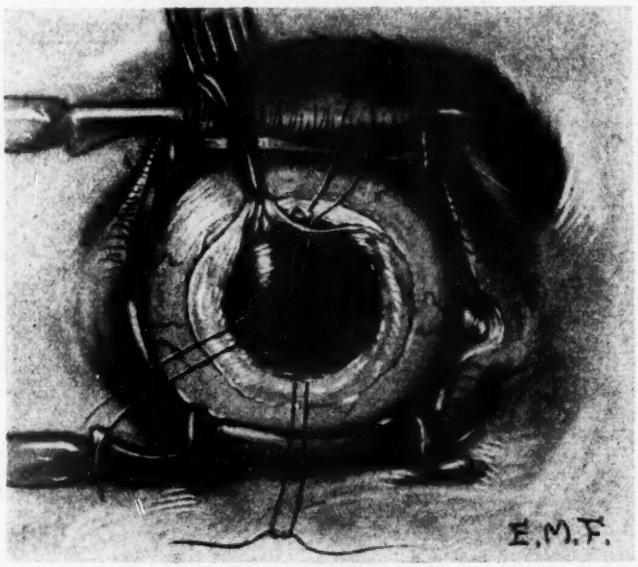

Fig. 3.—Scleral sutures placed through the margin of the transplant.

The cornea of the blind eye was now severed after the same technic as that used on the eye of the donor. The two small attachments of the cornea were severed last by means of scissors, so that the cut surface might conform as far as possible to that of the transplant. The corneal tissue thus removed was left in position for the moment, while the transplant was clipped free from the two small attachments (by means of scissors) and at once lifted up and placed on the scleral cut surface of the eye, from which the opaque cornea was at the same time lifted off. At this time it was noted that the iris was held in position and without injury, and the pupil remained small and round (from physostigmine miosis), so that the lens also retained its position, without dislocation or apparent subluxation. The previously prepared scleral sutures were then passed through the conjunctival flap close to the corneal margin of the transplant (fig. 3), and these, together with conjunctival sutures, brought the cornea down apparently in exact coaptation. The iris, now only slightly displaced by this procedure, was stroked from the

periphery by a spatula to a fairly round pupil. The cornea was clear and transparent. No solutions were used at any time, but physostigmine, 0.5 per cent, was now instilled and the eye bandaged.

The eye was dressed on the fifth day. There had been no complaint of pain or discomfort, and there was presumably only that which might be experienced after cataract extraction. A mild reaction of the lids was noted. The conjunctiva was in position and normally injected; it was apparently healing firmly without any chemosis or hemorrhage; the cornea was in its normal position, its surface regular and without opacity, though the substance was moderately but diffusely hazy; the iris could be seen distinctly; the anterior chamber was completely restored; there was no hyphemia or exudate, and the pupil was slightly oval in the vertical meridian. A drop of warm solution of physostigmine, 0.5 per cent,

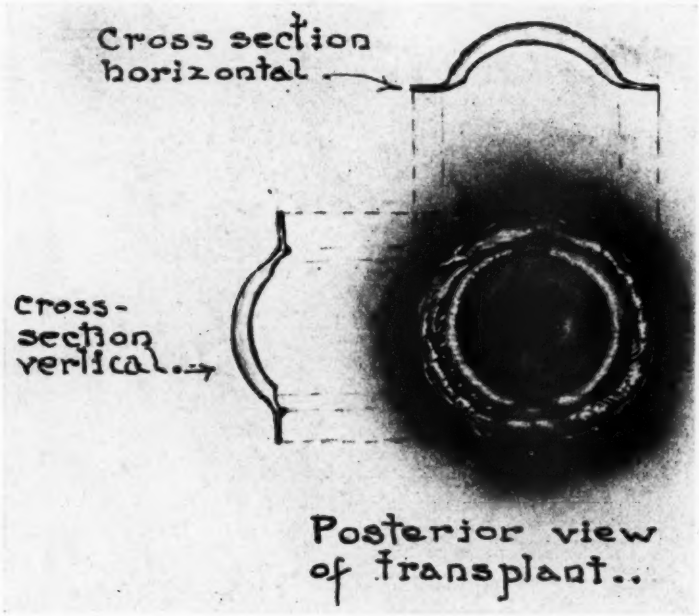

Fig. 4.—Posterior view of the transplant.

was instilled. The patient was given a tonic of iron, quinine and strychnine night and morning, whisky (1 ounce) at noon and an alcohol rub once a day.

Three days later (eighth postoperative day), there was marked improvement. The conjunctival injection was reduced; the corneal substance was clear; there was a fairly normal luster of the cornea, but Descemet's membrane was slightly opaque; the pupil, a trifle oval vertically, was clearly seen to react sensitively to light; the patient could count fingers and differentiate them; he noted of his own accord the glasses that I wore, and he spoke to the physicians and nurses about his bed.

There was no marked change in the appearance of the eye until the dressing on the fourteenth day, when for the first time there was noted a small hemorrhage in the lower portion of the anterior chamber; the aqueous was a trifle cloudy, and the iris congested; the cornea was unchanged. There had been some disagreement among those observing the case from time to time as to whether or not

atropine should be instilled and physostigmine discontinued. Since we had no precedent to follow except our experience under fairly similar conditions, the question was reasonably debatable. A drop of a 1 per cent warm solution of atropine was instilled. The artist made a drawing of the eye at that time; this is submitted in illustration of its appearance (fig. 5), but does not represent the eye at its best, which was at the time of the previous dressing.

There was no material change for another week (twenty-one days after operation), the eye being dressed every forty-eight hours; then it was observed that a second small hemorrhage had occurred in the anterior chamber, the previous one having been absorbed; the pupil was moderately dilated, and there was apparent hypertension on palpation. The atropine was now discontinued, and fairly hot fomentations were applied for fifteen minutes twice a day.

Fig. 5.—Conjunctivocorneal transplant on Nov. 8, 1928, fourteen days after operation.

At the end of another week there was little change. From time to time there was a tendency to hypertension when atropine was instilled, but no intense iritis or exudate in the anterior chamber was noted at any time. The sutures were removed as they appeared to be freeing themselves; the scleral sutures, which were the last to be removed, seemed to hold firmly until their removal appeared advisable on the twenty-first day. The visual acuity was diminished noticeably after the second small hemorrhage occurred in the anterior chamber. From this time, the corneal substance gradually became a trifle cloudy, but at the end of six months the patient could detect fingers and move about fairly well. Hypertension subsided after atropine was discontinued and did not return; its absence seemed a satisfactory observation in a case of this sort. Deep injection did not

persist for as long a time as might be expected, and no cyclitic pain or other symptoms were present. The eye was entirely quiet in six weeks.

Then followed a long period of little change. During my absence one of my associates instilled 5 per cent ethylmorphine hydrochloride in an effort to clear the corneal substance and to observe the result. A violent reaction followed, but without effect except to produce a slight permanent vascularity of the lower nasal portion of the cornea and perhaps increase the opacity at this location.

The illustration here presented (fig. 6) was made on Dec. 26, 1929, one year and two months after operation, and shows clearly the appearance of the eye when last observed, one year and seven months after operation. The vision of the eye was limited to seeing hand movements or shadows. The outcome must be regarded as unsatisfactory so far as restoration of useful vision is concerned. It was an attempt—an experiment perhaps—but it showed, I believe, that this operation can be performed with fair results if properly done and if suitable postoperative care and treatment are administered. This experience has shown the need of certain improvements in technic, as well as in the postoperative treatment, which may be of value in future attempts to transplant the cornea.

The principal complications that arose in the course of the operation and in the after-care in this case are:

1. An extensive orbital hemorrhage occurred when the blind eye was anesthetized by deep orbital injection. This hemorrhage produced marked swelling of the lids with forceful postbulbar pressure, which made difficult the dissection of the symblepharon and the folding of it into the fornix with sutures through the upper lid. This also threatened to cause prolapse of the iris, and it increased the difficulty of performing a suitable removal of the opaque cornea because of the temporary artificial hypertension. This was especially noted when contrasted with the tedious but much more easily performed removal of the transplant from the donor's eye, in which the iris remained in the normal position and with no protrusion of the parts whatever, although physostigmine had not been instilled in this eye. This complication also made the suturing of the transplant on its new site more tedious and more hazardous than would have been the case otherwise.

2. The dissection of the cornea at the limbus with the cataract knife was a difficult procedure and it might have been facilitated if the corneal margin had first been split forward 1.5 mm., as in the trephine operation, at the locations for the introduction and use of the cataract knife. At one stage of this tedious dissection, at the upper nasal side of the blind eye, the cataract knife could not be carried up to the upper limbus, not because of the lack of a resistance at the fulcrum—since the lower corneal attachment and the forcep's grasp of the cornea supplied this—but because the handle of the knife impinged against the side of the nose

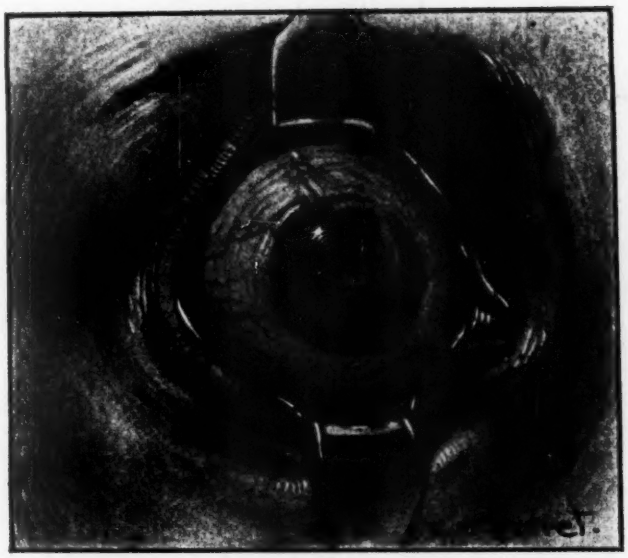

Fig. 6.—Conjunctivocorneal transplant on Dec. 26, 1929, one year and two months after operation.

even when the globe was rotated somewhat temporalward. This small portion, therefore, required the use of scissors. The details of preparation and operation consumed three and one-half hours, although a large part of this time was required for the preparation of the anesthesia, for making an external canthotomy and for dissecting and suturing the symblepharon. Also much time was lost because of inexperience with this technic, which was so exacting that each step had to be taken at the correct time in preparation for the next.

3. The removal of the symblepharon and its attending difficulties, because of the swollen tissues of the orbit, added considerably to the time necessary to perform the operation. Furthermore, the surface of the upper culdesac, in which the transplant must, for the most part, rest when the lids were closed, was of necessity uneven and did not, of course, rest smoothly and in exact contact on the surface of the transplant, as would otherwise have been the case.

4. Intra-ocular hypertension arising during the postoperative care was a complication which had to be reckoned with and which was anticipated. The incision made in the limbus of both eyes was carried as far anteriorly as possible in order to escape the apex of the iris angle and thus to avoid destruction of Schlemm's canal. This, of course, could not be carried out as accurately as one would like, and where the scissors were necessary, it could not be avoided altogether. Hypertension, however, did not prove to be a permanent complication, since the tension was normal and no ocular symptoms of hypertension were manifest when the patient was last examined.

5. The behavior of the patient was in some respects a trying complication. While obedient and forbearing in most respects, he was too sure of success, after two weeks of peeping into the light again, to resist taking liberties which were often discouraging. To enumerate these details is unnecessary, but the following is an illustration: Three weeks after the operation, the patient was found on the fire-escape (in November), smoking a cigaret!

The factors that are believed to have contributed to the accomplishment of the transplantation of this cornea are:

1. No solutions were used during the operation, nor was the graft placed in a solution to await further preparation; on the contrary, it remained in normal contact with the sclerotica as before, with two corneal attachments, while the blind eye was being similarly prepared to receive it.

2. Deep orbital anesthesia was employed, although this proved to be a complication to some degree in this instance.

3. The free external canthotomy permitted the control of lid pressure.

4. The scleral sutures were essential in firmly fixing the upper and lower margins of the graft.

5. The method of removal of the cornea with a large keratome and cataract knife was used for the purpose of securing a slanting flat cut surface for the transplant and to avoid as far as possible injury to Schlemm's canal. It is obvious that this method allows a broader and more exact surface contact of the transplant to the scleral cut surface than could be secured by the use of scissors. It also affords the scleral sutures a pinning action on the cornea, which causes the slanting cut surfaces to be pressed firmly against each other (figs. 3 and 4). This can be appreciated when one is reminded that the two small attachments of the cornea left intact by this method until finally severed by scissors, thus leaving a break in the smooth flat surface of the graft, allowed the pinning action of the scleral sutures at these points to press the cut surface of the graft laterally and firmly on the flat cut surface of the sclera of the blind eye. It is also important to note that the small corneal attachments thus left intact acted as a suitable fulcrum while the section was made in this manner by means of the cataract knife.

6. The rapidity of the method of actual transplantation when each cornea had been prepared seems important, the upper and lower corneal attachments being severed with scissors and the transplant transferred immediately with the upper and lower limbus placed on the upper and lower limbal contacts of the scleral cut surface.

7. Both patients were comparatively young—the blind patient being 26 and the donor 32—which no doubt had a favorable influence.

The results of this experiment are:

1. The transplant was a complete "take."

2. The transplant has been retained in its normal position and without loss of substance, conjunctival or corneal, for one year and seven months.

3. There has been no displacement of the transplant; the surface epithelium is intact, the surface round and regular, and a large portion of the corneal substance has remained fairly clear.

4. The bulbar conjunctiva, the subconjunctival tissue and sclera and the blood vessels of these tissues are normal in appearance. No scar line denoting the limitations of the conjunctival transplant is noticeable except under magnification. This is an especially striking feature of the upper bulbar conjunctiva, where the large symblepharon was removed and only the conjunctival transplant furnished the epithelial covering, and where undoubtedly epithelial proliferation must have taken place.

5. The anterior chamber has been maintained from the time of the first dressing (five days after operation).

6. The pupil has remained slightly oval and without incarceration of the iris.

7. There is no permanent hypertension; in fact, the tension measures from 22 to 26 mm. (Schiötz).

8. The patient has not complained of any pain in the eye or about the orbital region significant of an iritic or cyclitic reaction, nor has he complained of any irritation of the eye.

9. This operation can be performed without injury to the iris or lens and, of course, without loss of vitreous. Removal of the cornea, properly performed, does not lead to collapse of the globe with protrusion of the iris and lens, much less to the emptying of its contents, as is commonly believed must take place.

COMMENT

Only two methods of corneal transplantation seem to deserve consideration. One is that of central trephining, with transplantation of a true corneal graft, supplemented by a conjunctival covering which gives it mechanical support and supplies it with nourishment from its blood vessels. This method and modifications of it have been attempted by many surgeons since 1837, when Bigger [1] performed a number of transplantations on animals but without success. In 1872, von Hippel [2] conceived the idea of trephining for the removal of the graft, a method which was followed by Fuchs,[3] Zirm,[4] Magitôt,[5] Morax,[6] Elschnig [7] and Filatow.[8] The corneal flap method was devised by Löhlein [9] in 1912. It was my privilege to examine a patient operated on by Elschnig and referred to me by Dr. Harry Gradle, in whom both corneas had

1. Bigger, S. L. L.: The Possibility of Transplanting the Cornea, Dublin J. M. Sc. **11**:408, 1837.

2. von Hippel, A.: Transplantation der Cornea, Arch. f. Ophth. **24**:235, 1878; Ueber Transplantation der Hornhaut, Ber. ü. d. Versamml. d. ophth. Gesellsch. **18**:54, 1886; **19**:30, 1887; Eine neue Methode der Hornhauttransplantation, Arch. f. Ophth. **34**:108, 1888.

3. Fuchs, E.: Ueber Keratoplastik, Wien. klin. Wchnschr. **7**:843, 1894; Zur Keratoplastik, Ztschr. f. Augenh. **5**:1, 1901.

4. Zirm: Ueber Transplantation der Hornhaut, Wien. klin. Wchnschr. **2**:240, 1907.

5. Magitôt, A.: Human Keratoplasty, Tr. Internat. Cong. Med., London, 1913, p. 157.

6. Morax, V.: Keratoplastie par transposition, Clin. opht. **19**:108, 1913.

7. Elschnig, A.: Ueber Keratoplastik, Prag. med. Wchnschr. **39**:405, 1914; Ueber Keratoplastik, Ber. ü. d. Versamml. d. ophth. Gesellsch. **42**:331, 1920; Keratoplasty, Arch. Ophth. **4**:165 (Aug.) 1930.

8. Filatow, W.: Ein Fall von Hornhauttransplantation, Arch. f. Augenh. **102**:716 (Feb.) 1930.

9. Löhlein, W.: Successful Method of Corneal Transplantation, Arch. Ophth. **41**:266, 1912.

been trephined and a graft, 4.5 mm. in diameter, exactly fitted into place. Both were fairly transparent, but showed considerable vascularity; vision was from 1/200 to 2/200. The patient was able to come to New York by train alone. I advised against further operation.

The method of total corneal transplantation was first attempted by Shimanowski, who performed corneociliaroplasty on a young man. In 1920, Burke [10] reported two cases of keratoplasty. It was after this method that the present operation was patterned.

As to the selection of suitable cases for this experiment, it is obvious that the procedure is justified only in a single blind eye or when both eyes are totally and hopelessly lost beyond optical iridectomy, vision being reduced to seeing shadows only, this condition being due, with reasonable certainty, to dense opacity of the cornea. Systemic syphilis or tuberculosis must be regarded as definite contraindications.

The eye of the donor is a problem of some consideration. Cases of severe injury are rarely suitable, owing of course to disturbance of circulation, as almost invariably some injury has occurred to the graft. It would seem, therefore, that eyes with small intra-ocular tumors, before hypertension may have affected the nourishment of the cornea, are the most suitable for this purpose. It has been suggested that the possibility of transmitting the malignant growth must be considered. On the other hand, the pathologic process of the eye should be one's guide; under reasonable conditions, the possibility of this complication does not seem to justify much uncertainty. Considering all the hazards in this problem, one may not anticipate this development.

Given a successful transplant of the cornea, without loss of substance, without iridocyclitic complications and without hypertension, the question arises as to the cause of gradual opacification of corneal substance after a period of from six weeks to two months although the conditions of nourishment apparently are normal. That it is a question of nourishment seems to be reasonably certain. Is the aqueous nourishment deficient, or does the contact of the aqueous with the corneal substance, Descemet's membrane having been severed, gradually produce opacity of the substance in the same manner as traumatic cataract is formed when the cortex of the lens is in contact with aqueous fluid? The management of this phase of the problem seems to be the experiment of the future.

For reasons which it is unnecessary to mention, I believe that conjunctivocorneal transplantation is the operation of choice; that the method of securing a flat cut surface of the corneal graft is essential; that the cut surface must slant forward to escape Schlemm's canal; that four scleral sutures would be preferable to two, placed in position with-

10. Burke, J. W.: Total Keratoplasty, Tr. Am. Ophth. Soc., 1920, p. 440.

out loss of time or endangering the integrity of the graft; that the actual transplantation should be made at once by severing the corneal attachments with scissors; that no solutions should be used to irrigate the eye or the graft at any time; that pilocarpine (warm) should be the principal postoperative medication; that a free external canthotomy should be performed, and that orbital anesthesia should be carefully administered.

With this experience as a guide, I believe that this operation can and will be performed with reasonable restoration of vision. It is recognized, of course, that given two suitable cases, such as it was my privilege to have studied, this operation is well within the skill of any competent ophthalmic surgeon who has the facilities for its performance.

Clinical Notes

MULTIPLE NEUROFIBROMAS OF THE NASOCILIARY NERVE *

H. V. Phelan, M.D., Cleveland

The following case is presented on account of the rarity of the condition and the clinical observations that masked the diagnosis.

History.—A man, aged 42, of Lithuanian descent, a sheet metal worker, had an essentially unimportant family history in regard to the complaint. He was referred to me because of a swelling of the inner aspect of the lower lid of the right eye, which he had first noticed two years previously. The swelling had been getting progressively larger, and at the time of examination interfered with his vision for close work.

Examination.—Physical examination revealed a tumor mass about the size of a hazelnut in the inner aspect of the lower lid of the right eye. It did not seem to be attached to the lid itself. The conjunctiva was elevated, obliterating the cul-de-sac, and was bluish; no attachment was perceptible. There was no dislocation of the globe. The movements of the eyes were normal, except for some impairment on looking down and in. Vision was normal. The fundi were normal. The right naris was full of polypi, with hypertrophy of the right middle turbinate. The left naris was fairly normal. A roentgenogram of the sinuses showed cloudiness of all the right sinuses, but did not show any involvement of the orbit.

For want of a more accurate diagnosis, I tentatively diagnosed the condition as a meibomian cyst of the lid. I advised removal, but told the patient that the operation was liable to be extensive, as I was not sure but that there was cancerous degeneration of the polypoid condition in the right ethmoid in spite of the negative roentgen observations. He would consent only to the removal of the visible tumor, regardless of its extent.

Operation.—With the patient under local anesthesia of procaine hydrochloride, 1 per cent and epinephrine chloride 1 : 50,000, an incision was made over the most prominent part of the tumor, from the inner canthus to the center of the lid in a fold of the skin. The fibers of the orbicularis oculi were separated, and the surface of the tumor was exposed. Profuse bleeding was encountered. The tumor was adherent to the surrounding structures and was dissected out with difficulty. On palpation of the orbit, a thin pedicle was found which extended back to the posterior ethmoid cells, with several nodules, the size of a split pea, in its stem, at intervals of about 10 mm. Its only attachment seemed to be at the apex of the orbit. The tumor itself was friable, and its surface was roughened, suggestive of carcinoma. Two silk sutures were inserted in the skin and a pressure bandage applied.

* Submitted for publication, Dec. 22, 1930.

* Presented before the Section on Ophthalmology and Otolaryngology of the Cleveland Academy of Medicine, April 25, 1930.

In the microscopic pathologic report it was said that the tumor was made up of connective tissue base, the cells of which were rather numerous, being made up of fibroblasts and large elongated cells. The diagnosis was neurofibroma.

Fig. 1.—Appearance of patient at the time of examination.

Fig. 2.—Microscopic section of the neurofibroma, showing a whorl-like structure of nerve fibers and fibrous tissue.

Course.—On questioning the patient about other similar lumps on his body, he said that he had two on the right side of his back. They were about the size of walnuts and were in the posterior axillary line just below the ribs. They had been present for a great many years.

On reviewing the case, I realized that that which I had thought was the stem or pedicle of the tumor was a thickened nasociliary nerve with nodules of fibromatous tissue in its stroma.

On looking up the literature on this condition, I was not able to find anything that was exactly similar to it in regard to location, the nearest account being an excerpt from the book of Sir Holburt Waring,[1] surgeon at St. Bartholomew's Hospital, London: "When a tumor within the orbit can be palpated distinct from the eyeball and distinct from the walls of the orbit and can be freely moved a diagnosis can be made of a primary sarcoma in this region, provided there is no evidence that the patient is suffering from malignant disease elsewhere."

As far as I have been able to find, there has not been a case of this condition reported to have occurred in this particular region. The most common location for a neurofibroma of the orbit is in the upper lid and outer quadrant and in the lid itself.

Six months after the removal there was no evidence of recurrence of the tumor, although there was a brawny swelling in this region. The visual impairment was not as pronounced, although the patient was still conscious of the infiltration.

A year and a half after the first operation, the patient again came under my observation, with a recurrence of the tumor. It was much larger than when he was first seen. Owing to the nature of the tumor and its incomplete removal at the time of the first operation, this was to be expected.

He was sent to the hospital, where a general anesthetic was given. The tumor was dissected free, except on its medial aspect, where it was adherent to the lamina papyracea. This area was detached by dropping a tonsil snare wire over the growth. It was thus removed in toto. The two small tumors felt at the first operation had coalesced, and had formed one tumor the size of a walnut.

1. Waring, Holburt J.: The Surgical Treatment of Malignant Disease, New York, Oxford University Press, 1928, p. 646.

THE SCHAAF FORCEPS FOR THE REMOVAL OF FOREIGN BODIES*

P. CHALMERS JAMESON, M.D., BROOKLYN

I have found the forceps designed by Dr. E. Schaaf [1] of Strassburg so valuable and so excellently adapted for its purpose that I wish to bring it to the attention of the ophthalmic surgeons in this country. The instrument is designed for removing foreign bodies from the cornea with or without supplementary instrumentation. I have never found a forceps that will grasp and hold a minute foreign body as well as this one.

Sometimes it will be found very helpful in removing foreign bodies from the corneas of children with one quick movement, when an instrument cannot be manipulated for any length of time, but it is

* Submitted for publication, Jan. 13, 1931.

1. Schaaf, E.: Bull. Soc. franç. d'opht., 1926.

most valuable in grasping and removing the base plaque of exudate which so often remains. Frequently after the plaque has been loosened and freed by a spud or other sharp instrument, a valvelike hinge persists, which requires much time to remove and causes much trauma. This instrument is unique in grasping, holding and accomplishing the removal of this obstinate remainder.

The fringe of stain or débris, after the foreign body and base plaque have been removed, can also be grasped and the facet cleared of all débris and foreign material.

The construction of this forceps is worthy of study. At first glance it might seem that the designer had made it too large and clumsy, but this impression is soon dissipated when the objects he had in view are recognized.

Three definite needs are supplied:

1. The precisely tapered and co-apted points assure an accurate grasp of the foreign body or plaque.

Dr. E. Schaaf's forceps for removal of foreign bodies from the cornea.

2. The broad, thick substantial blades, rounded and strong as they approach the points, provide assurance that there will be no lateral displacement of the blades.

3. The stop projections on the inner surface of one blade provide means to prevent the points from spreading or opening when much pressure is brought to bear on the blades. These projections, two in number, are so regulated in length that not more pressure can be exerted on the points than will be sufficient to grasp and to hold securely. This prevents opening or separation of the points.

These principles are conspicuously absent in some tooth forceps, which become weakened after they have been in use for some time, permitting the blades to fall off laterally and the points to gap if pressure is exerted on the blades.

The instrument, I feel sure, is a most helpful and valuable addition to one's instrumentation for work on corneal foreign bodies. It is so well thought out and constructed that it is doubtful that it will ever be improved.

This instrument may be obtained from P. Moria, 108 Boulevard, Saint Germaine, Paris, or E. B. Meyrowitz, 520 Fifth Avenue, New York.

News and Notes

EDITED BY DR. JOHN HERBERT WAITE

GENERAL NEWS

American Board for Ophthalmic Examinations.—The American Board for Ophthalmic Examinations will hold an examination at Philadelphia on June 8, and at Denver on July 23, 1931. Information may be obtained from the Secretary, Dr. William H. Wilder, 122 South Michigan Avenue, Chicago.

Prize in Ophthalmology.—Announcement is made of the Middlemore Prize to be awarded for the best essay or work on any subject which the council of the British Medical Association may from time to time select in any department of ophthalmic medicine or surgery. The council is prepared to consider an award of the prize in 1932 for the best essay on "Sympathetic Ophthalmia Before and After 1914." Essays must reach the medical secretary, British Medical Association House, Tavistock Square, London, W. C. 1, not later than December 31. Each essay must be signed with a motto accompanied by a sealed envelope, marked on the outside with the motto, and containing the name and address of the author. If no essay is of sufficient merit, the prize will not be awarded in 1932.

The Howe Laboratory of Ophthalmology.—The Howe Laboratory of Ophthalmology at the Massachusetts Eye and Ear Infirmary is now in the process of organization. It will be directed by a committee consisting of Dr. George S. Derby, Chairman, Dr. F. H. Verhoeff and Dr. Hans Zinsser.

Quarterly Journal on Prevention of Blindness.—The *Sight-Saving Review* is a new journal issued for the first time in March by the National Society for the Prevention of Blindness. The magazine, a quarterly, is planned to serve both popular and technical groups, including social workers, ophthalmologists, illuminating engineers, educators and others interested in the sociological phase of saving sight. The editorial board includes Dr. Edward V. L. Brown, Chicago; Dr. William H. Wilmer, Baltimore; Dr. Edward Jackson, Denver, and Dr. Thomas D. Wood, New York. Lewis H. Carris, managing director of the society, is editor. The first issue contains articles on glaucoma, lighting, conservation of vision in schools, the status of work on the prevention of blindness in the United States and an appreciation of the late Ernst Fuchs.

Public Health Circular on Eradication and Prevention of Trachoma.—Since 1912, the Public Health Service has been conducting a campaign in various sections of the United States directed toward the eradication of trachoma. Trachoma, sometimes called "granulated eyelids," or "red sore eyes," is an inflammation of the lining of the eyelids. Among the white population of the United States trachoma is

not confined to any sharply defined area, but in general is prevalent in West Virginia, Kentucky, eastern Tennessee, western Virginia, Missouri, Arkansas and Oklahoma. In connection with this work, small hospitals usually located in residences provided by the community have been established in areas in which this disease prevails. Much progress has been made toward eradicating the condition, but there are yet many cases of trachoma that require treatment, particularly in the mountainous areas of the country. A statement recently issued by the Public Health Service, "Advice to Persons with Trachoma," is as follows: 1. Place yourself under treatment by a reputable physician without delay—a specialist if possible. Continue treatment until the physician dismisses you. 2. Do not be discouraged if your doctor fails to cure you in a few weeks. Many cases of trachoma require treatment off and on for two or three years. 3. Keep your face clean, especially about the eyes. 4. Have clean handkerchiefs or clean cloths to wipe your eyes with. See that they are boiled or burned after use. 5. Do not leave your towel, soap or washbasin where other persons can use them, or they may also get trachoma. 6. Babies may contract trachoma; so be careful in cleaning the baby's eyes to use wash rags that have been boiled. 7. Persons with trachoma should not be exposed to dust. However, if you must work in a dusty place, dust goggles will give you some protection. Wear them only when working in the dust. 8. Remember that the wearing of dark glasses continuously tends to weaken the eyes. Wear them only when you are in bright sunshine. 9. Glasses will not cure trachoma. Do not let anyone sell you glasses in the hope that they will cure your condition.

Dust (Abstract from Circular H-23, released by the United States Public Health Service).—"Dust can never be for long out of our thoughts or our eyes. It bears an important relation to fogs and rains. It causes our colorful sunsets. The air is never free from it. Volcanic dust has been found thousands of miles from its source. Pollen from Alaska has been carried far into this country." In certain manufacturing processes, dust has hygienic significance. Some dusts are poisonous, some act as mechanical irritants to skin and mucous membranes, and occasionally dust attains explosive proportions. Poisonous dusts found in industry are derived from lead, mercury, arsenic, manganese and zinc, and less often from tobacco, aniline products and certain kinds of wood. Certain types of dust are irritating to the conjunctiva, such as that from arsenic and varieties of wood. Sterile dust placed in the conjunctival sac is known to bring about an increase in the bacterial content of the conjunctival secretions. Occupational conjunctivitis is seen in cigarmakers, in stone and metal workers, and in those preparing aniline dyes.

SOCIETY NEWS

Ophthalmological Society of the United Kingdom.—The program for the Annual Congress of the Ophthalmological Society of the United Kingdom at London on April 23, 24 and 25, 1931, was as follows: April 23: Mr. Foster Moore, Non-Luetic Argyll Robertson Pupils; Dr. Gordon Holmes, Iridoplegia Associated with Other Nervous Symptoms; Dr. Ritchie Russell, Leber's Optic Atrophy; Dr. Norman H. Dott and Mr. A. H. Sinclair, A Case of Brain Tumor; Mr. Herbert

Fisher, Report of Two Cases of Nystagmus; Mr. Arthur W. Ormond, Notes on a Case of Osteitis Deformans with Ocular Symptoms; Discussion, Affections of the Eye Due to Virus; Mr. Alexander MacRae, A Case of a Hole at the Macula. April 24: Mr. J. H. Doggart, Epithelial Dystrophy of the Cornea; Miss Ida Mann, Development of the Cornea; Dr. A. J. Ballantyne, A Case of Detachment and Reflection of the Retina, and Congenital Cataract with Unusual Features; Mr. Gordon Wright, New Method of Treating Gonococcal Conjunctivitis in the Adult; Mr. M. S. Mayou, Treatment of Chronic Blepharitis; Mr. W. A. Gray, Retinal Vessel Changes in Diabetes; Mr. R. C. Davenport, Some Practical Points in Light Intensity; Mr. Bernard Chavasse, The Nature and Antiquity of Stereopsis; Air Vice-Admiral Munro, Vision in Sport; Mr. J. R. Paterson, Some Notes on Eye Conditions in Compensation Cases in Scottish Miners; Mr. A. D. Griffith, Squint and Binocular Vision; Miss Maddox, The Orthoptic Treatment of Strabismus; Sir Almroth Wright, Vaccine Therapy; Dr. A. H. H. Sinclair, Intracapsular Extraction of Cataract. April 25: Mr. S. Spence Meighan, Case of Retinitis Pigmentosa Treated by Cervical Sympathectomy; Mr. J. Tudor Thomas, Experimental Transplantation of Cornea in a Rabbit to Replace a Central Opacity; Mr. H. M. Traquair, Toti's Operation; Mr. C. Shapland, Analysis of 100 Cases of Retinal Detachment Treated by Cautery Puncture. This was followed by the annual general meeting and a visit to the National Institute for Medical Research, Mount Vernon, Hampstead, by invitation of Professor Dale.

New York State Medical Society.—The Annual Meeting of the New York State Medical Society will be held in Syracuse, N. Y. The papers to be read in the Section on the Eye, Ear, Nose and Throat, on June 2 and 3, that are of interest to ophthalmologists are the following: Management of Eye Injuries, Dr. Nelson S. Weinberger, Sayre, Pa. (by invitation); Discussion, Dr. Walter S. Atkinson, Watertown, N. Y.; Recent Advances in Ophthalmic Surgery, Dr. Webb W. Weeks, New York; Discussion, Dr. Arthur J. Bedell, Albany, N. Y.; The Place of the Otorhinolaryngologist in Treatment of Eye Diseases, Dr. E. Ross Faulkner, New York; Discussion, Dr. Thomas H. Halstead, Syracuse, N. Y.; Evaluation of all Etiologic Factors in Eye Diseases, Possibly Secondary to Disease of the Ear, Nose and Throat, Dr. James G. Dwyer, New York; Discussion, Dr. Searle B. Marlow, Syracuse, N. Y.; Detachment of the Retina, Its Treatment, Dr. Edmond E. Blaauw, Buffalo, and Discussion, Dr. David H. Webster, New York. The Chairman of the Section is Dr. Conrad Berens, New York.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

EXPERIMENTAL STUDIES ON THE DEVELOPMENT OF THE EYE: III. THE EFFECT OF THE SUBSTRATE ("UNTERLAGERUNG") ON THE HETEROTOPIC DEVELOPMENT OF MEDIAN AND LATERAL STRIPS OF THE ANTERIOR END OF THE NEURAL PLATE OF AMBLYSTOMA. HOWARD B. ADELMANN, J. Exper. Zool. **57**: 223 (Oct.) 1930.

The influence of the substrate on the eye-forming potencies of the median and lateral thirds of the anterior end of the neural plate of *Amblystoma* was tested by the transplantation of the strips with and without substrate to the belly walls of older hosts. Only 11.1 per cent of 90 transplants of lateral strips without substrate developed well formed eyes, while 54.4 per cent of 145 transplants of lateral strips with substrate formed eyes. The substrate evidently reenforces the eye-forming potencies of the lateral regions of the neural plate. In the case of median strips, 70.8 per cent of 89 transplants without substrate developed well formed eyes, while 72.6 per cent of 113 transplants with substrate formed eyes. The eye-forming potencies of the median third of the neural plate are therefore higher than those of the more lateral areas. While the substrate in the stages considered has little, if any, "reenforcing" effect on the eye-forming potencies of the median strips, it may possibly have exerted such an effect in stages earlier than those used.

The substrate has an interesting effect on the character of the eyes formed from the transplanted median strips. Two distinct eyes separated by ventral brain floor were formed in 47.6 per cent of eighty-two transplants of median strips with substrate, while no such cases were found in those without substrate. In addition, 23.2 per cent of the transplants of median strips with substrate formed two eyes, one of which was rudimentary. In sixty-three transplants of median strips without substrate, 73 per cent formed perfectly single eyes resembling cyclopean eyes in their relations to the implanted brains. It is concluded that the substrate is responsible for the bilateral character of the development of the eyes in the transplants of median strips with substrate.

A case is described in which the donor formed an eye from a right lateral third of the anterior end of the neural plate left in situ, while eyes were formed from both the median and left lateral strips of the anterior end of the neural plate from the same donor when transplanted to older hosts. The evidence indicates that the eye-forming materials of the neural plate alone constitute a harmonic equipotential system capable of forming either one eye or two eyes, according to the conditions of development. While the eye-forming materials of the neural plate alone constitute a potential unit, it is not correct to say that a single median eye is present in the early neural plate. Although eye-forming

potencies of the neural plate alone are higher in the median regions, the evidence of excision and staining experiments points to the conclusion that during normal development more lateral regions are also involved in the development of the eyes.

L. C. WYMAN.

Aqueous Humor

THE FORMATION OF THE EHRLICH LINE. YOSIMITI TUTUI, Arch. f. Augenh. **103:** 580 (Dec.) 1930.

The author has studied the appearance of the typical Ehrlich line in a series of animals. He finds that it occurs in practically all the animals investigated, rabbits, rats, fish, turtles, chickens, fox, barn owls, doves, canaries, dogs, cats and screech owls. It is absent in the mouse, the carp, the ape and man. In the mouse its absence is apparently due to the fact that the eye is too small for any difference in temperature to exist in the parts of its anterior segment. It is absent in the carp because the aqueous contains a threadlike substance which prevents the convection currents. The fluorescein, therefore, sinks to the bottom of the anterior chamber without forming a line. The absence in man and in the ape is to be explained by the low protein content of the aqueous; as a consequence, the particles of fluorescein are too finely divided to form a definite line.

F. H. ADLER.

Bacteriology and Serology

THE CHOLESTEROL CONTENT OF THE BLOOD IN GLAUCOMATOUS PATIENTS. A. L. MUSSELEVICH, Russk. arch. oft. **7:** 529 (June) 1930.

The author examined the serum of forty-one patients suffering from glaucoma, and that of ten patients who had arteriosclerosis without glaucoma. Of these patients, thirty-two suffered from chronic, seven from absolute and two from acute glaucoma. A description of the calorimetric method used is given. A slight hypercholesteinemia was observed in a few patients, mostly in women, who under normal conditions have a higher blood cholesterol content than men. He believes that the reported observations of many authors that hypercholesterinemia is associated with arteriosclerosis and also with glaucoma have no basis in fact.

O. SITCHEVSKA.

Cornea and Sclera

KRUKENBERG'S SPINDLE. E. V. SRINIVASAN, Brit. J. Ophth. **14:** 602 (Nov.) 1930.

The patient was a woman, aged 27. The refraction error in the right eye was a mixed astigmatism, and in the left eye a simple hyperopic astigmatism, the axis of the correcting cylinder at 180 degrees. Each cornea presented in the vertical axis a chocolate-colored patch 3.5 mm. long by 1 mm. wide at the broadest central part. The pigment seemed to be on Descemet's membrane, but in the absence of a biomicroscope it could not be accurately located. In the right fundus there was a

right-angled, bright, white, fibrous scar to the nasal side of the disk. This to the author suggested that the whole condition is a congenital anomaly. The pecularity of the case is that the left eye is not myopic, and the right eye has only about a diopter of myopia.

W. ZENTMAYER.

NEUROPARALYTIC KERATITIS IN HEMIANESTHESIA OF THE OPPOSITE SIDE. SANTIAGO BERENCHEA and G. VON GROLMAN, Arch. de oftal. de Buenos Aires **5:** 510 (Nov.) 1930.

A syphilitic patient with arterial hypertension, vertigo and hemianesthesia of the right side had as a complication a neuroparalytic keratitis of the left side with anesthesia of the left cornea and left side of the face. The author localized the lesion (probably a small hemorrhage) in the pons. He has found only one other similar case, reported by Liegard before the Ophthalmological Society of Paris in 1911. He concludes: 1. Claude Bernard's doctrine that neuroparalytic keratitis indicates a lesion of the gasserian ganglion or its efferent branches and that it is not liable to occur in trigeminal lesions posterior to the ganglion is not tenable. 2. Bulbar hemianesthesia can be complicated, although rarely with neuroparalytic keratitis of the opposite side. 3. The trigeminal anesthesia in this case solely affected the superficial sensibility, in accordance with the observation of Hartmann and Souques, that deep sensibility, which is also preserved after section of the sensitive root of the gasserian ganglion, is a property of the facial nerve.

C. E. FINLAY.

CYSTS OF THE CORNEA AFTER BURN WITH CHLOROFORM. A. LOEWENSTEIN, Klin. Monatsbl. f. Augenh. **85:** 218 (Aug. 1) 1930.

A man, aged 20, immediately after an appendectomy in 1924, showed congestion of the left eye caused by a burn with chloroform. Small white vesicles remained at the lower border of the cornea after irritation had ceased. According to the patient's statement, these remained stationary. When first examined by the author, in June, 1929, three prominent hard cysts of varying size were noticed. A grayish-brown zone, about 1 mm. wide and extending into the deeper layers of the parenchyma, was seen at the temporal side of the smallest cyst. The sensitiveness of the cornea was reduced in the area of the cysts and toward the pupil. The eye was normal otherwise, and the vision perfect. The cysts were removed in November, 1929, shortly after the eye had become congested again. Microscopic examination showed destruction of Bowman's membrane in the area of the cysts, due probably to the protracted detachment of the epithelium. This phenomenon suggests that an injury can produce a latent pathologic condition which, after a number of years, may lead to an inflammation through the interference of some noxious influence later. No changes were found in the nerves, either histologically or with the slit-lamp, to explain the disturbance of the corneal sensitiveness.

K. L. STOLL.

Experimental Pathology

SPECIFIC REACTIONS IN EXPERIMENTAL TUBERCULOUS KERATITIS IN RABBITS. A. Y. SAMOILOFF, Russk. arch. oft. 7: 721 (Oct.) 1930.

The author selected for his studies rabbits in which tuberculous keratitis had been produced experimentally by the introduction of the bovine tubercle bacilli into the corneal parenchyma two months previously.

He divided his experiments into two series. The first series of three rabbits received subcutaneous injections of 0.1 cc. of Koch's old tuberculin in a 1 : 1,000 dilution, which is equal to one twentieth of the maximal human dose. In the second series nonspecific protein (0.5 cc. of milk) was introduced into the thigh of two rabbits. In all rabbits the rectal temperature was taken daily. The corneal infiltration and the change in the blood vessels were observed under the slit-lamp a few days before and after the injections. The intra-ocular tension was taken by Fick-Livschitz' tonometer.

There was no local reaction at the site of the injection in the rabbits of the first series; the temperature was raised slightly in two rabbits. The focal reaction of the corneal lesion was present in all rabbits of this series on the second and third day after the injection. The infiltration was pink, and an increase of vascularization and numerous extravasates were present. The participation of the uveal tract in this process was indicated by the lowering of the intra-ocular tension from 24 to 18 mm. Eight days after the injection of tuberculin, autopsy showed no signs of generalized tuberculosis. The second series of rabbits that were inoculated with milk did not show any local reaction, elevation of temperature or focal reaction of the tuberculous lesion of the cornea.

The author draws the conclusion that there is a definite specificity of the focal reaction of tuberculous corneas. He also believes that, since there were no signs of generalized tuberculosis, the rise of the temperature in two rabbits was caused by the activation of the process in the diseased eye. Specific therapy, therefore, in cases of sluggish tuberculous keratitis which causes fever should not be feared as a possible stimulating factor of general tuberculosis. O. SITCHEVSKA.

General Diseases

MIKULICZ'S DISEASE AND MIKULICZ'S SYNDROME: TREATMENT BY IRRADIATION. T. LEUCUTIA AND A. E. PRICE, Am. J. Roentgenol. 24: 491 (Nov.) 1930.

On the basis of a study of nine cases, Leucutia and Price believe that "the symmetrical enlargements of the lacrimal and one or more pair of the salivary glands," originally described as Mikulicz' disease, should be divided into two main groups: Mikulicz' disease and the Mikulicz syndrome. Under Mikulicz' disease are included all cases of symmetrical, noninflammatory swellings of the lacrimal and salivary glands without involvement of the lymphatic system and without alteration of the blood. Under the Mikulicz syndrome are included the cases in which the enlargements of the lacrimal and salivary glands are manifestations of some clinically and pathologically well defined disease, such as leukemia, tuberculosis, syphilis, lymphosarcoma, Hodgkin's disease

and uveoparotid fever. In the first group, the technic of the radiation therapy is based on the principle that there is a lymphocytic infiltration with an organized structural arrangement, so-called lymphadenoma of the affected lacrimal and salivary glands. This implies that divided doses (from 15 to 50 per cent of an erythema dose) spread over a longer period are more beneficial than the one single massive dose administered in neoplastic processes. For the same reason, the quality of the rays used is of considerably less importance. In the second group, since the involvement of the lacrimal and salivary glands is merely a manifestation of a more or less distinct clinical entity, a technic should be used which conforms to the routine procedure of irradiation applied in that particular entity. It has been repeatedly suggested that Mikulicz' disease proper be considered an "aleukemic stage" of leukemia. There are two reasons why this should not be done: 1. The average duration of life is considerably longer in Mikulicz' disease than in either the acute or the chronic form of leukemia. 2. The radiosensitivity of the lymphocytic infiltration, because of its organized structural arrangements, is definitely less in Mikulicz' disease than in the more malignant and consequently less differentiated lymphocytic proliferations in leukemia.

[J. A. M. A.]

DIFFERENTIATION AND SIGNIFICANCE OF CERTAIN OPHTHALMOSCOPIC PICTURES IN HYPERTENSIVE DISEASE. A. M. FISHBERG AND B. S. OPPENHEIMER, Arch. Int. Med. **46:** 901 (Dec.) 1930.

In 274 cases of hypertensive and renal diseases the ophthalmoscopic observations were studied by Fishberg and Oppenheimer in relation to the clinical picture; in 39 of the cases, postmortem observations were also made. The concept of albuminuric retinitis includes 3 distinct pathologic entities, which can most often be differentiated with the ophthalmoscope: (*a*) arteriosclerotic retinopathy, (*b*) malignant hypertensive neuroretinitis and (*c*) choked disk due to increased intracranial tension from edema of the brain. The ophthalmoscopic characteristics of these 3 types of retinal changes are described, and their occurrence and prognostic significance in the individual types of hypertensive disease investigated. In all of the 10 cases of essential hypertension with malignant hypertensive neuroretinitis in which the patients came to necropsy, necrosis of the renal arterioles was present. On the other hand, necrosis of the renal arterioles was absent in 11 instances of essential hypertension without malignant hypertensive neuroretinitis that were studied at necropsy. Instances are described of malignant hypertensive neuroretinitis in patients with arterial hypertension due to suprarenal tumor and of arteriosclerotic retinopathy accompanying hypertension resulting from an amyloid contracted kidney.

[J. A. M. A.]

OCULAR SYMPTOMS IN A CASE OF MYASTHENIA WITH TUMOR OF THE THYMUS. J. KLAR, Klin. Monatsbl. f. Augenh. **85:** 224 (Aug. 1) 1930.

In a woman, aged 53, the uterus, containing a tumor weighing 13 pounds (5.9 Kg.), and one ovary were removed in 1917, at the age of 41. Marked adiposity had developed since the operation. No pathologic

symptoms were noticed until Quincke's edema of the lids appeared, in 1928. At certain intervals she was barely able to open her eyes. Transient dyspnea, difficulty of speech and urticaria were recorded in January, 1929. This case of severe pseudoparalytic myasthenia of a remittent type also showed ptosis, paralysis of the abducens nerve of the right eye and of the inferior rectus muscle of the left eye, causing diplopia, and paralysis of the frontal and ocular branches of the facial nerve and of the respiratory muscles. The intra-ocular muscles were intact. The fundus of both eyes was normal. The vasomotor disturbance of the lids and the urticaria were thought to be caused by a toxin produced by a tumor of the thymus.

Irradiation or extirpation of the tumor in a case of this type may bring about recovery. A similar, hitherto unreported case of Auerbach's is mentioned. A patient died with symptoms of dyspneic paralysis. In this case the tumor of the thymus was a lympho-epithelioma which showed no signs of malignancy. The muscles of different regions of the body showed no changes resembling the structure of the tumor; the central and peripheral nervous systems were histologically normal.

K. L. STOLL.

Glaucoma

GLAUCOMA WITH PREMENSTRUAL EXACERBATIONS. C. COSTI, Arch. de oftal. hispano-am. **30:** 521 (Oct.) 1930.

The author reports a case that he considers unique; he did not find a similar relation mentioned in the literature. He discusses the relations of ocular tension with the sympathetic system and the variations in the female neurovegetative system during the menstrual epoch. In comparing the results of Goetsch's test at different dates, he found, in his case, an increased sympathetic tonus during the premenstrual period, which coincided with a corresponding increase in the arterial tension.

C. E. FINLAY.

THE EXCHANGE OF FLUID BETWEEN BLOOD AND TISSUE IN GLAUCOMA. WILHELM WEGNER, Arch. f. Augenh. **103:** 511 (Dec.) 1930.

The author discusses the various theories of the etiology of glaucoma and calls attention to the fact that these may be divided into two main groups: (1) those in which the local pathologic processes are regarded as the primary cause, and (2) those in which glaucoma is considered a disturbance of the general body.

He then refers to the work of Schmidt, Seebeck and others who used the test described by Marx for the determination of changes in the permeability of the blood capillaries. This test consists in the drinking of a definite quantity of distilled water following which the hemoglobin is estimated at short intervals and the amount and specific gravity of the urine are determined. In the normal individual a characteristic change is shown in the dilution of hemoglobin and in the output and the specific gravity of the urine. It makes very little difference how much distilled water is taken; even 50 Gm. is sufficient to produce the characteristic curves. This indicates that the taking of water causes changes in the body itself and that the results obtained are not simply due to a dilution of the blood.

The present paper deals with the results of this test carried out in a number of cases of chronic simple glaucoma and four cases of chronic inflammatory glaucoma. In 70 per cent of the first group he confirmed the observations of Schmidt, that there is a definite disturbance of the capillary endothelium. In the small, second group, he also felt that the course of the test showed an abnormal behavior of the capillary endothelium.

These experiments lend weight to the theory that glaucoma is a general disease and not just a local disturbance. F. H. ADLER.

IRIDENCLEISIS. JOSEP BLAICKNER, Ztschr. f. Augenh. **72**: 265 (Oct.) 1930.

A critical review of the operations in which incarcerated iris is utilized to relieve increased intra-ocular tension is given. The author speaks of the several methods employed and describes his procedure. A protocol of forty-two cases is given. His results show that the vision improved in 85 per cent of the cases; the tension remained normal (under 26 mm. of mercury) in the same percentage, and the visual field, after a period of from four to forty-five months, remained the same or improved in 66 per cent. The opening in the sclera made during this operation should be considered as a trap rather than as a fistula. In successful cases the anterior chamber is rarely completely emptied during the stage of restoration of the aqueous humor. The fluid finds its way out into Tenon's capsule only when there is increased intra-ocular tension. Rarely is infection seen when the scleral opening is covered properly by the conjunctiva. Miotics are not required after a successful operation. The unfavorable results found following iridencleisis are probably due, in part, to the improper choice of cases for operation. The operation is contraindicated when there is a swollen lens, in juvenile glaucoma, in cases in which lenticular changes require future cataract extraction and when the lens is dislocated. The success of this undertaking compares well with that reported by Gjessing.

A. M. YUDKIN.

Injuries

CILIARY WOUND AND HERNIA CAUSED BY BURSTING GLASS: RECOVERY WITH CONSERVATION OF THE EYE. H. TRUC AND C. DEJEAN, Arch. d'opht. **47**: 676 (Oct.) 1930.

The authors present the case of a man, aged 21, who suffered from a penetrating wound of the ciliary region. The wound was contused, irregular and about 5 mm. in size, with considerable prolapse of the ciliary body. The wound was cured without leaving a trace, except for a hardly visible scleral scar where the wound was covered with a large conjunctival flap without the use of scleral sutures. The classic treatment for such wounds is enucleation. Truc has previously expressed himself against the common practice of excising herniated iris, and he collects several references in support of his contention. The interest in this case lies in the fact that such an extensive wound healed perfectly under a simple conjunctival flap. S. B. MARLOW.

INJURIES OF EYE CAUSED BY RADIANT ENERGY. A. VOGT, Schweiz. med. Wchnschr. **60:** 1121 (Nov. 29) 1930.

Vogt directs attention to the fact that, under certain conditions, sunshine as well as artificial light may cause temporary or permanent injuries of the eyes. It has long been known that looking into the sun, as during solar eclipses, is followed by temporary or permanent scotoma. The author found that this injury is mainly due to an injury of the macula lutea by burning of the pigment epithelium and neuro-epithelium by the infra-red rays. Another injury caused by sunlight is the snow-blindness developing in high mountains. This is caused by ultraviolet radiation, which injures especially the cornea and conjunctiva. Glass-blowers' cataract, the pathogenesis of which was not entirely clear until recently, is caused by infra-red radiation. Roentgen injuries of the eye become noticeable either shortly after irradiation or after a longer interval. The author advises against the treatment for blepharitis with small doses of roentgen rays, because this disturbance usually yields to medicinal therapy, and although roentgenologists assert that small doses of roentgen rays are not injurious to the eye, the late effects on the lens cannot be definitely denied. Injury of the eye may also be caused by radium rays; it is similar to that caused by roentgen rays.

[J. A. M. A.]

Lens

CATARACT OPERATIONS IN EXTREME OLD AGE. R. H. ELLIOT, Brit. M. J. **1:** 132 (Jan. 24) 1931.

In contrast to the statement frequently heard, that "the patient is too old for operation for removal of cataract," Colonel Elliot reports on five successful operations: four on persons 90 years and over, and one just before the patient's ninetieth birthday. He has operated on many patients between the ages of 80 and 90. Though the operation for cataract sometimes seems to be a shock to the patient, and life is sometimes shortened thereby, in all of the five cases mentioned not only was the operation successful, but no shock was observed nor was life shortened. Colonel Elliot believes these remarkable results to be due to an extraordinary vitality that has enabled the patients to live at least twenty years beyond the usual span of life, and that makes them good subjects for an operation. If conditions are such as were present in these cases, he believes that operations are much safer in extreme old age than they often are in the sixth and seventh decades of life.

A. KNAPP.

CATARACT OPERATION. RAUL ARGAÑARAZ, Arch. de oftal. de Buenos Aires **5:** 261 (July-Aug.) 1930.

The author favors intracapsular extraction according to Elschnig's method, which he describes in detail. He operates with the patient in bed, utilizes a preliminary pupillary dilatation, disinfects the lids with Dakin's solution and flushes the conjunctiva with physiologic solution of sodium chloride. He makes use of facial akinesia, injecting procaine hydrochloride at the exit of the facial nerve from the stylomastoid foramen. He employs a preliminary retrobulbar injection, fixes the superior rectus muscle, makes a conjunctival flap and applies preliminary sutures.

He performs the extraction with Elschnig's or Basterra's forceps aided by a squint hook, and he performs an iridotomy after the extraction. In the last six months he has performed forty-seven operations; details of twenty-two are given. C. E. FINLAY.

Neurology

DISTRIBUTION OF LIPOID IN A CASE OF NIEMANN-PICK'S DISEASE ASSOCIATED WITH AMAUROTIC FAMILY IDIOCY. H. SOBOTKA, E. Z. EPSTEIN AND L. LICHENSTEIN, Arch. Path. **10:** 677 (Nov.) 1930.

An analysis of the lipoids of the spleen, liver and brain in a case of lipoid histiocytosis (Niemann-Pick) associated with amaurotic family idiocy showed: (1) the disappearance of neutral fat; (2) a considerable increase of phosphatides and cholesterol, particularly cholesterol ester, and (3) the absence of kerasin. [J. A. M. A.]

EYE OBSERVATIONS IN EPIDEMIC CEREBROSPINAL MENINGITIS. PHIL M. LEWIS, South. M. J. **24:** 101 (Feb.) 1931.

Thirty-three of sixty-five patients with meningitis were found to have normal eyes. Thirty-two, or 49 per cent, showed some deviation from the normal. In thirteen cases, or 20 per cent, the changes consisted simply in hyperemia of the disk and retina or engorgement of the retinal veins. Real pathologic change was encountered in nineteen cases, or 29 per cent.

Three cases of convergent squint were found. There were few pupillary changes. Iridochoroiditis or endophthalmitis was found in twelve eyes (nine patients). It usually developed in the first week or ten days of the disease, never after the second week. The condition was discovered by routine ophthalmic examination or by the patient's finding that he could not see with one or both eyes. Moderate ciliary injection was the only external indication. All cases ended in blindness of the involved eye. In two cases an orbital cellulitis developed. Three cases showed papillitis. Thirteen showed same vascular changes. In seven there was definite hyperemia of the disk and retina. Two cases showed blindness without any ophthalmoscopic changes.

Of the thirty-two patients with ophthalmic changes, seven died. Of the patients who recovered, five were permanently blind in one eye, four from endophthalmitis and one from a central lesion. Three children were left with complete and permanent blindness of both eyes.

There is no specific treatment for the ocular conditions. Atropine and epinephrine are used to prevent and break up the posterior synechiae. The main treatment is the administration of antimeningococcic serum, both intraspinally and intravenously. F. W. SCHLUTZ.

Ocular Muscles

LATENT NYSTAGMUS. A. SORSBY, Brit. J. Ophth. **15:** 1 (Jan.) 1931.

Latent nystagmus is a condition in which nystagmus not normally present when both eyes are open, becomes manifest on the occlusion of one eye or through the action of other stimuli.

Five cases are reported, three occurring in children and two in adults. In three of the cases, there was squint of the convergent type.

The author states that all the writers on the subject have assumed that latent nystagmus is a distinct entity with constant clinical features. This the author doubts because these case reports deal with that which is true for the particular case rather than with a class as a whole. He stresses that repeated examinations of these cases have revealed inconsistencies in all of them. He points out that many of the theories advanced mutually cancel each other for the obvious reason that they regard as an essential factor a feature present only in the particular case or group of cases, being absent in another group, and this absent feature giving rise to a contrary theory. The literature is reviewed and analyzed.

W. ZENTMAYER.

PARALYSIS OF THE OCULOMOTOR NERVE WITH UNUSUAL SYMPTOMS. J. SZEKELY, Klin. Monatsbl. f. Augenh. **85:** 229 (Aug. 1) 1930.

A boy, aged 16, suffered a fracture of the skull and injury of the brain in a fall. His right eye showed ptosis and the symptoms of complete paralysis of the oculomotor nerve. The globe was turned toward the median line and downward. The trochlear and abducens nerves were intact, slight exophthalmos of about 2 mm. was present, the vision was reduced to 0.6 and accommodation was impaired. The disk appeared 45 degrees out of its usual location, corresponding to the turn of the globe itself. The left eye was normal. The fracture of the skull, about 5 to 6 cm. in length, began at the right parietal region and involved the frontal fissure and the round foramen, while the orbits were unaffected.

The abnormal action of the trochlear nerve is explained as the result of either direct irritation by a hemorrhage or increased tonus of this antagonist of the paralyzed muscle.

K. L. STOLL.

Orbit, Eyeball and Accessory Sinuses

OPHTHALMOLOGIC ASPECTS OF CRANIAL SINUS THROMBOSIS. W. L. BENEDICT, Proc. Staff Meet., Mayo Clin. **5:** 367 (Dec.) 1930.

The usual conditions observed around the orbit as a result of thrombosis of the great venous sinuses of the head are exophthalmos, edema of the orbit and lids, progressive external ophthalmoplegia with faulty ocular rotation, nystagmus, pupillary phenomena, dimming of vision, disturbances of retinal circulation and changes in the optic nerve head. As many of the changes may be brought about by other causes, a differential diagnosis should be made by one who has had considerable experience in ophthalmic practice, if a proper evaluation of ocular changes is desired.

Thrombosis of the cavernous sinus is usually first suspected after the appearance of swelling of the lids with proptosis, and when signs of septicemia have appeared in a case of infection about the head. Fever, malaise, headache, disturbances of motility of the eye, proptosis and sometimes visual disturbances are present. Examination of the retina may show that the veins are engorged, but often only after other symptoms have been present for two or three days. Motor disturbances are

caused by pressure on the third, fourth and sixth nerves as they pass through the sinus. Choked disk results from obstruction to the flow from the central vein. Local diseases within the orbit, such as cellulitis, tumor and tenonitis may cause similar symptoms. Unilaterality of symptoms is helpful in differentiation. In most cases of thrombosis of the cavernous sinus the condition is bilateral.

Thrombosis of the lateral sinus causes changes about the eyes in less than 10 per cent of the cases observed. Choked disk is the most commonly observed change, and it occurs only when intracranial extension takes place, such as meningitis, abscess or extension of the thrombosis to the sinuses. Choked disks have been reported in cases of disease of the mastoids without sinus thrombosis or other signs of intradural involvement.

With the knowledge that choked disk may occur in surgical disease of the mastoids, with or without thrombosis of the lateral sinuses, the only conclusion that one can reach regarding the condition is that some unknown intracranial involvement has taken place. Probably the gravity of the situation is heightened if choked disk follows frank septic phlebitis of the sinuses. In more than 100 cases of septic phlebitis of the sinuses observed on Dr. Lillie's service, less than 10 per cent showed changes in the fundus. Progressive choked disk has been found only when the patients were extremely ill and the illness went on to a fatal termination.

Thrombosis of the longitudinal sinus was found in fifteen cases in which the fundus was also examined. In none of this group was there anything about the eyes to suggest thrombosis except the dilatation of the veins over the lids and forehead, as mentioned by Doyle, and this was noted in only one case. In the absence of tumor of the brain or involvement of the cavernous sinus, choked disk was not observed in this group of cases.

W. ZENTMAYER.

THE ORIGIN OF TRAUMATIC ENOPHTHALMOS. A. BIRCH-HIRSCHFELD, Ztschr. f. Augenh. **72:** 259 (Oct.) 1930.

Birch-Hirschfeld points out the fallacy of attributing traumatic retraction of the eyeball to any single factor, such as paralysis of the trophic branches of the fifth nerve, sympathetic lesions, detachment of the superior rectus, diminution of the orbital fat, increase in the size of the orbital socket by fractures of the walls, cicatrization following inflammation and hemorrhage, tearing of ligaments, displacement of the orbital tissue and ischemia of the orbit due to irritation of a central vasomotor area.

He believes, however, that a combination of the aforementioned factors most likely produces enophthalmos.

A. M. YUDKIN.

The Pupil

MISLEADING POSITION OF THE PUPILS IN NORMAL EYES. Z. ISRAELEVICH, Vrach. gaz., Oct. 15, 1930, p. 1420.

Determination of the position of the pupils is important in the diagnosis of diseases of the central nervous system, especially of neurosyphilis. Israelevich describes a case observed in a young man with

neurasthenia. On examination of the eyes, both pupils appeared to be located in the lower segment of the iris when the patient was looking upward, so that their lower edge reached the margin of the iris. The pupils were round and slightly dilated. There were no other pathologic signs. The pupils appeared to be displaced to the upper segment of the iris when the patient was looking downward, and their upper edge reached the corresponding margin of the iris. Again the form and size of the pupils remained unchanged. They appeared at the left when the patient looked to the right, and at the right when the patient looked to the left. They were seen in the middle of the iris only when the corneal centers of the examining physician and those of the patient were situated on the same perpendicular plane. Obviously there was no actual displacement of the pupils, only an apparent one. The phenomenon was frequently observed in healthy persons. In order to avoid a diagnostic error, the pupil should be examined always in five positions: namely, when the patient looks up, down, to the right, to the left and forward. The nature of the phenomenon has not been ascertained; probably some physical properties of the eye are responsible for it.

[J. A. M. A.]

Physiology

THE INTRAOCULAR PRESSURE AND DRAINAGE OF THE AQUEOUS HUMOR. F. RIDLEY, Brit. J. Ophth. **15:** 102 (Feb.) 1931.

This is a reply to Duke-Elder's criticism of the author's paper on intra-ocular pressure and drainage of the aqueous humor in which he brings forward experimental evidence that the normal living cornea is permeable to diffuse substances and that the osmotic pressure due to the tear protein and the hydrostatic force exerted by the intra-ocular pressure determine the constant passage of fluid through the cornea.

Regarding Duke-Elder's conclusive experiment that the cornea is not an available channel of exit since no blue is seen in the cornea or conjunctival sac, but proving that the blue has passed into the episcleral veins via Schlemm's canal, Ridley says that it proves only that blue will appear in the episcleral veins in one and a half minutes. The explanation is to be found in the fact that: "In the lower animals, e. g., the dog, the venous anastomoses are large and most of the blood from the eye is returned to the extraocular venous system, while in man it normally flows into the intraocular system" (Parsons).

Ridley meets the other critical comments of Duke-Elder, but these were not considered in the previous abstract of Duke-Elder's paper, and as their consideration would consume too much space, the controversy will have to be read in the original.

W. ZENTMAYER.

VITAL STAINING OF THE POSTERIOR SEGMENT OF THE GLOBE. KUNIMARO KIKAI, Arch. f. Augenh. **103:** 541 (Dec.) 1930.

Systematic studies on the vital staining of the posterior segment have not been made in the living animal, except for the work of F. P. Fischer (*Arch. f. Augenh.* **100:** 480, 1929). In his studies, chief attention was paid to the staining of the anterior segment. The present studies con-

cern the intravenous injection of dyes into albino rabbits. Following the injection, the animals were examined with the ophthalmoscope, and the eyes were then quickly enucleated and the retinas examined. Occasionally, the retinas were fixed by the gelatin-freezing method and sectioned. The author found that only the acid dyes, such as fluorescein, eosin, trypan blue and Chicago blue, colored the retinal vessels. Neither the basic dyes nor sodium indigo acid sulphate colored the retinal vessels.

The basic dyes used were malachite green, methyl violet, crystal violet, bismarck brown, isamine blue, aniline blue, bayrisch blue, diamant black, pyronine G, basic fuchsin and trypflavin. These dyes stain the retina and choroid at the moment of injection. Almost immediately, however, they become decolorized. If the retinas are taken out, the coloring comes back again. This primary decoloration in the retina is due to a reduction of the dye by the tissues. Methyl blue, methyl green, toluidine blue, naphthylene blue, brilliant cresyl blue and neutral red stain the cellular elements of the retina, but can be demonstrated only in flat preparations and not ophthalmoscopically.

Methylene blue (methylthionine chloride, U. S. P.) stains the layers of the nerve fibers and ganglion cells chiefly, while brilliant cresyl blue is selective for the amacrine cells. The acid sulphur dyes, such as fuchsin S, etc., stain the choroid and leave the retinal vessels and retina without the dye. The choroid appears to be more acid than the retina, which remains in an alkaline condition.

F. H. ADLER.

THE PARTICULATE SIZE OF INTRAVENOUSLY INJECTED DYES IN SERUM AND AQUEOUS. F. P. FISCHER, Arch. f. Augenh. **103**: 554 (Dec.) 1930.

In a previous paper the author expressed the view that the passage of dyes from the blood into the aqueous and cerebrospinal fluid depended on their colloidal properties, especially on their particulate size and the charge which they carried. At that time these factors could not be accurately measured. Recently, however, Furth and others have developed physical methods of measuring the particulate size of dyes, and in this paper the author deals with measurements of the dyes used in the previous work.

He measured the diffusion coefficient of different dyes in watery solution, in blood serum, in primary and secondary aqueous and in serum filtrates of different protein concentration. He finds that in watery solutions only a small portion of dye diffuses according to the theory of diffusion. In the majority of cases deviations occur which must be considered as anomalous diffusion. He considers that dyes which diffuse more rapidly than eosin, which appears in the aqueous and cerebrospinal fluid, are in a state of finer dispersion than eosin, and do not come out of the blood because their charge, which is the opposite of eosin, prevents them; for certainly their degree of dispersion cannot be the cause. All dyes diffuse more slowly in serum than in water, apparently because of absorption by the protein, but even in serum a number of dyes show anomalous diffusion. Fluorescein was the only dye studied in relation to aqueous. It diffuses more rapidly in primary aqueous than in serum, but more slowly than in water. The diffusion in secondary aqueous is about equal to that in serum.

F. H. ADLER.

Refraction and Accommodation

DISCUSSION OF THE ELEMENTS UNDERLYING PROGRESSIVE AXIAL MYOPIA. H. T. TURNER, Pennsylvania M. J. **34**: 173 (Dec.) 1930.

The conclusions of Fischer and Ruben constitute an hypothesis on which most of the problems of axial myopia may be logically explained and many apparently unrelated elements correlated on the basis of an element common to each, viz., the production of acids, proteolytic ferments or other reagents that increase the hydration capacity of the hydrophilic colloids of the posterior segment, thus producing a chronic water-logging.

Having a common action, the combined effect would be a massed one, in spite of the different character of the reagents involved.

It is logical to assume that a prolonged water-logging of the sclera and choroid, produced in this manner, may result in trophic changes with diminished resistance in these tissues, so that a simultaneous increase in the bulk of the vitreous, produced in the same way, may push the weakened sclera backward, without any increase in ocular tension.

A certain hypothetic toxicity must be assumed necessary to overcome the normal resistance of the tissues, represented by the alkaline buffers of the fluids and tissues of the body. If the total toxicity falls short of this, a degenerative change does not follow; if it equals or exceeds it, a degenerative change does develop, the rapidity of the change varying with the degree of toxicity.

It is probable that in most cases several elements are involved, any one of which may be the determining factor that completes or exceeds that total degree of toxicity needed to overcome the normal balance and to precipitate the pathologic status.

The congenital influence may be explained by the effect of pathologic changes secondary to congenital syphilis, the uric acid diathesis or by an hereditary dysfunction of the endocrine system.

Unilateral axial myopia, almost without exception, is secondary to a homolateral pathologic condition in the nose and throat.

W. ZENTMAYER.

ACCOMMODATION FOR DISTANCE. K. NOISZEWSKI, Arch. d'opht. **47**: 601 (Sept.) 1930.

In this report Noiszewski presents evidence in support of the possibility of accommodation for distance. He refers to the work of Aleksandrowiez, who proved that accommodation for distance is accomplished in cephalopods by the forward displacement of the lens. He cites the anatomic observations on the development of the ciliary muscle by E. Fuchs, who was unable to explain the usefulness of the meridional fibers. He believes that the theory of Laugenbeck, which was rejected by Helmholtz, is correct, except for the fact that the action of the circular muscle by compression is indirect. The "tension choroideae" acts by drawing the choroid and retina forward to improve vision for distance. This continual drawing forward of the retina may perhaps explain why detachment is so common in myopes. He presents a table giving the amount of accommodation for distance in twenty-five cases of myopia.

This was estimated first by determining the visual acuity without glasses, then the improvement obtainable by squinting and finally by placing the concave glass before the eye, which improved the vision up to that obtained by squinting. The power of this glass he calls the amount of accommodation for distance. It amounted to 8 diopters in one instance.

S. B. MARLOW.

Retina and Optic Nerve

PROGRESSIVE BILATERAL LESIONS OF THE MACULA IN YOUNG SUBJECTS (DISEASE OF STARGARDT). SCHIFF-WERTHEIMER and M. H. TILLÉ, Ann. d'ocul. **167**: 1 (Jan.) 1930.

Tillé and Schiff-Wertheimer report two cases of progressive lesions of the macula in young subjects, and have studied the relation of these cases to progressive, familial macula degeneration (Stargardt's disease). In both cases there is a horizontally oval patch of retinochoroidal disturbance in the macular region, with pigmentation. They insist that the lesions in their two cases were similar to those in the cases described by Stargardt, despite the absence of any familial history. They conclude by stating that it seems justifiable to reserve the name of Stargardt's disease for retinal lesions of special form that affect the macula of adolescents. This condition is frequently but not necessarily familial, and is slowly progressive. They doubt that this clinical picture should be classified among retinal degenerations, but place it rather among manifestations in certain young subjects in which the etiology is not always the same.

G. BERENS.

TWO CASES OF DETACHMENT OF THE RETINA IN THE NEW-BORN. P. PESME, Arch. d'opht. **47**: 464 (July) 1930.

The observation of retinal detachment in infants less than a year old seems to be rare, according to the literature. However, it appears less so if those eyes are included that are enucleated for glioma and shown to be pseudogliomatous on microscopic examination. Two cases representing these two possibilities are presented; the first proved to be a pseudoglioma, and the second an uncomplicated detachment. The author discusses these two cases from the etiologic, anatomic and pathogenic points of view. He refers to the observation of Lachman that pseudogliomas may have a brownish appearance, which perhaps is of some value in differential diagnosis. The question is raised after a review of the cases reported and the histories obtained in these two cases as to whether or not tuberculosis in some form or other may not be the most important underlying causative factor. He suggests that further observations from this standpoint would be most useful.

S. B. MARLOW.

SCLERORETINAL CAUTERIZATION IN DETACHMENT OF THE RETINA. M. VAN LINT, Arch. d'opht. **47**: 597 (Sept.) 1930.

Van Lint believes that retinoscleral thermocauterization is the best surgical treatment for detachment of the retina. Although Gonin's operation is designed to close a tear in the retina, Van Lint states that

this is not always accomplished but that an adhesion between the retina and the sclera always results. The most difficult part of Gonin's technic is the accurate localization of the tear. Van Lint expresses the opinion that all that is necessary is to cauterize at the most accessible place in the detachment. Admitting that his idea may seem to be a scientific heresy, he points out that there is no absolute proof of the etiologic rôle of retinal tears in the production of detachment of the retina. Moreover, Gonin has reported some cures in which the tear was not closed either because one was not discovered or because it was too large. In spite of the doubt that may exist as to the rôle of tears, Van Lint feels that it is useful to localize them, for cauterization is more effective in contiguous areas. In the author's opinion, the great merit of Gonin's work is not to have proved that detachment of the retina can be cured by cauterization of a tear, but rather to have shown that the eye will withstand the introduction of a thermocautery or a galvanocautery into the vitreous without harm.

In the case of detachment, it is necessary to localize the site of the detachment, and, if possible, to find the tear, to perform the puncture and to cauterize as near the tear as possible.

S. B. MARLOW.

DETACHMENT OF THE RETINA. ANTONIO J. MANES and HORATIO B. MOULIE, Arch. de oftal. de Buenos Aires **5**: 288 (July-Aug.) 1930.

This is a report of observations on examinations, investigations and treatment of retinal detachment in different clinics during a trip in 1930. The authors first describe Sourdille's pathogenetic theory based on a disturbance of the coaptation between the pigment epithelium and the retina proper, owing to lesions affecting the circulation in the choriocapillaris, the appearance of subretinal fluid being generally secondary to the detachment. His treatment consists in the production of chorioretinal adhesion by means of injections and cauterizations. In 170 operations he obtained 71 perfect recoveries and 6 partial ones; 60 of the former occurred after three months and 9 after six months.

Amsler considers detachment as an episode in an ocular disease. In cases of retinal detachment it is necessary to examine separately the retina, choroid and vitreous. Gonin's operation is an emergency measure used to meet a complication. He obtained 70 per cent of recoveries in recent cases. Amsler's methods of search and localization of the retinal rupture are given in detail.

Elschnig prefers Gonin's operation; he has performed forty-eight operations, but has not yet arrived at a definite opinion. He agrees with Sourdille that it is not necessary to localize the rupture exactly.

Lindner accepts Gonin's views. The authors describe in detail his methods of examination and localization and his operative procedure.

C. E. FINLAY.

CHOLESTEROL CRYSTALS IN THE SUBRETINAL FLUID OF AN ATYPICAL RETINAL DETACHMENT. LIJÓ PAVIA, Arch. de oftal. hispano-am. **30**: 577 (Nov.) 1930.

The author reports a case of retinal detachment in which there was a shining aspect of the retina, with numerous brilliant spots and marked

mobility. A biomicroscopic examination of the fundus, with Bitumi's microscope and the slit-lamp, revealed an atrophic and sclerosed disk, from which sprang a number of proliferating cords and a thin retina, in which the vessels were supported by a delicate reticulum, through which a large number of brilliant underlying spots were visible. Examination of the subretinal fluid withdrawn by puncture showed physically a large number of cholesterin crystals and chemically the presence of 0.22 per cent of cholesterol.

C. E. FINLAY.

THE CAUSE AND RELATION OF RETINITIS AND DETACHMENT IN PREGNANCY. HERMAN STEWENS, Ztschr. f. Augenh. **72:** 293 (Oct.) 1930.

Two case reports are given; a primipara had acute retinal disturbance accompanied by detachment of the retina and a sextipara had chronic retinal changes accompanied by the same lesion. They had in common, edema, hypertension, an extremely high excretion of protein in the urine and detachment of the retinas. In the primipara, the renal disturbance was probably produced by the pregnancy, for chronic nephritis developed after interference of gestation, whereas the sextipara had chronic nephritis to start with and the condition was aggravated by child bearing. The author cites several cases like his own in which favorable reattachments of the retina were produced by termination of the pregnancy. In the first case, the detachment was probably due to hypertension and in the second case to an increase of nitrogen in the urine (azotemia). It seems, therefore, that no one factor can be responsible for retinal detachment during pregnancy.

A. M. YUDKIN.

THE ANATOMY OF SICKLE-SHAPED DEGENERATION OF THE MACULAR REGION IN THE RETINA. R. HANSSEN, Ztschr. f. Augenh. **72:** 360 (Nov.) 1930.

A complete histologic study was made of an eye enucleated from a man, aged 81. The outstanding changes were: a perivascular accumulation of lymphocytes at the periphery of the retina, similar areas of lymphocytes in the choriocapillaries adjacent to the macula and optic nerve, and small foci of similar cells in the lamina vitrea. The author believes that there is a destruction of the normal metabolic interchange in the inner vascular layer of the choroid rather than a primary retinal disturbance, as stated by Junius and Kuhnt.

A. M. YUDKIN.

GENESIS OF PAPILLEDEMA. ELIZABETH FISCHER, Ztschr. f. Augenh. **72:** 369 (Nov.) 1930.

The author reports a case in which there was papilledema on one side and atrophy on the other. A complete histologic study accompanied the legend. Several comments are made on the various theories of papilledema that have recently been advocated.

In an attempt to classify the case in question, the author notes that no one theory can be adapted for the condition, as there are many factors responsible for the lesion.

A. M. YUDKIN.

PAPILLEDEMA AND INTRA-OCULAR TENSION. A. F. RUMJANZEWA, Ztschr. f. Augenh. **72:** 391 (Nov.) 1930.

In twenty patients presenting definite papilledema the intra-ocular tension was taken before and after treatment. It was noted that the intra-ocular pressure before operative intervention to relieve intracranial pressure was within the normal range: from 10 to 18 mg. of mercury during the afternoon and from 15 to 18 mg. in the early morning. Following the intracranial operation the tension in the eye invariably rose to 30 to 35 mm. The intra-ocular pressure apparently was low when cerebral pressure was high and vice versa. The author attributes this manifestation to vascular changes; i. e., when the cerebral pressure is increased, the caliber of the vessels is diminished and hence the ophthalmic vessels secrete less; when the cerebral tension is released, the caliber of the vessels, the secretion and the intra-ocular tension are increased.

A. M. YUDKIN.

Trachoma

THE TRACHOMATOUS BODIES OF BONNET AND THE PERILIMBIC CORNEAL FOLLICLES OF TRACHOMATOUS PANNUS. TRANTAS, Arch. d'opht. **47:** 444 (July) 1930.

The author gives a brief résumé of Bonnet's description, and then goes on to give a description of his method of detecting these changes by corneolimbal diaphanoscopy. He also describes what he calls perilimbic follicles and differentiates them from the "ocelles" of Bonnet. The perilimbic follicles were present in 31 per cent of the trachomatous patients. The author expresses the opinion that these changes are worthy of careful study. He does not feel that they are pathognomonic per se. Their appearance may vary in different localities. In an appendix to his paper, he places himself on record as believing in the occurrence of acute trachoma.

S. B. MARLOW.

DOES ACUTE TRACHOMA EXIST? G. PACALIN, Arch. d'opht. **47:** 690 (Oct.) 1930.

The author points out that the present tendency is to consider acute trachoma the result of secondary infections. Meyerhof alone admits its occurrence, although it is rare, and he has never seen profuse secretion in the course of its development. In this report Pacalin presents certain observations the nature of which would be clarified if acute trachoma does occur. One is the absence of organisms in cases of acute trachoma, and a second the specificity of copper sulphate in the relief. He cites four cases that support his contentions. He suggests that the rôle of secondary infections has been exaggerated. He presents a table giving the incidence of these secondary organisms in cases of chronic trachoma and asks why the same organisms should be incriminated in acute trachoma. Furthermore, he asks why copper sulphate should have such a marked beneficial action in these cases if they are due to the secondary infections that are commonly well controlled by salts of silver and zinc.

S. B. MARLOW.

Society Transactions

EDITED BY DR. GEORGE S. DERBY

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

ALEXANDER G. FEWELL, M.D., *Clerk*

Dec. 18, 1930

H. MAXWELL LANGDON, M.D., *Chairman*

ROENTGEN THERAPY IN PITUITARY TUMORS. DR. GEORGE E. PFAHLER and DR. E. W. SPACKMAN.

Pituitary tumors are of especial interest to the roentgenologist because by means of the roentgen rays, some of the most valuable diagnostic evidence can be obtained, and because these tumors are the most suitable of all tumors of the brain for radiation therapy. Briefly, diagnostic evidence in such cases depends on an enlargement, destruction or deformity of the sella turcica which is produced by the pituitary tumor. Fortunately, these pituitary tumors, either sellar or suprasellar, can be definitely localized, and since they are almost centrally located in a spherical body, the head, as great a crossfire of roentgen rays as is needed can be used. As a rule, they are more radiosensitive than tumors elsewhere in the head.

It is known that acromegalia is usually due to adenoma of the anterior lobe, while adiposogenital dystrophy is usually due to suprasellar hypophyseal tumors which are often indicated by deposit of lime (Makenzie, Sosman and Hirsch). In some cases, however, the location of the tumor is best indicated by a careful ophthalmologic study.

The first case to be treated by roentgen rays was reported by Gramegna in 1909, with temporary success and then ultimate failure. Béclére, in 1913, however, reported the results of roentgen therapy in a 16 year old girl; the vision improved threefold, the menses appeared, the breasts and pubic hair developed, and she has been able to live a normal life for over twenty years.

The results of roentgen therapy are relief from symptoms of pressure, indicated chiefly by relief from headache and, to a greater or lesser degree, from ocular symptoms. Some cases do not respond at all to such treatment, and cystic tumors seemingly are more successfully treated by operation. The ocular symptoms show both objective and subjective improvement after roentgen therapy. The field of vision is increased, and a careful study of the fields of vision from time to time is the best objective means of recording progress or failure.

Since it is impractical to perform a biopsy in cases of pituitary tumor, and since the operation is more or less formidable, it would seem advisable to use irradiation within the limits of normal tissue toleration during a period of from six weeks to six months, with the patient under

the observation of an ophthalmologist and a neurologist. If there is no response or insufficient response during this time, then operation would seem advisable.

(The presentation was accompanied by a description of the technic used and the results obtained in five additional cases to those reported by seventy-six other authors who have written on this subject.)

DISCUSSION

DR. L. C. PETER: Dr. Pfahler's reference to the value of roentgen therapy in some of these growths, and also his reference to the fact that when the tumors are in the pouch of Rathke the results are not quite so satisfactory, leads me to mention two cases that came under my care during the last two years. Operation started the patients on the road to improvement, but it remained for roentgen therapy to complete the cure, at least in one case and perhaps in the other. As in most suprasellar tumors, in contrast to those below this level, choked disks were present in both instances.

DR. F. H. ADLER: A few years ago, in the *American Journal of Ophthalmology,* a case was reported of a child with supposed pituitary tumor who fell from a porch and landed on her head. After this fall all symptoms entirely disappeared. The author of the report supposed the tumor to be a cyst which had been ruptured by the fall, thus resulting in a cure.

On Dr. Baer's service at the Wills Hospital, we have at present a little girl with supposed pituitary tumor. Her only symptom is blindness. The disks show a postpapillitic atrophy, but there is no evidence of increased intracranial pressure. There has been a complete erosion of the sella into the sphenoid sinuses so that the tumor has decompressed itself. I saw the roentgenograms today, and I was naturally reminded of the case just referred to and the possibility of the same thing happening here. Do tumors of the pituitary body commonly erode into the sinuses? Are radium and roentgen therapy to be recommended in cases in which the vision is deteriorating due to increased intracranial pressure, and is the use of radiation justifiable in such a case or should one insist on surgical decompression?

DR. G. O. RING: (Reference was made to some of the more recent literature on disease of the pituitary body, and a case was reported in which vision had been preserved and even improved from April, 1928 to date by radiation.)

SURGICAL TREATMENT OF PITUITARY TUMORS. DR. CHARLES H. FRAZIER.

(The presenter drew attention to the enormous increase in knowledge of the pathology and symptomatology of disorders of the pituitary body since his first operation in 1912. At that time he was inclined to be content with the comprehensive term "pituitary lesion," but the pathology has since become complex. With the increased knowledge of the pathology and clinical manifestations of disorders of the pituitary body, the number of patients applying to the Neurosurgical Clinic has steadily increased, until at the present time 343 cases are recorded on the register for diseases of the pituitary body. Ninety-seven per cent of these patients seek relief because of failing vision, and the remaining

3 per cent for intolerable headache. Within the week prior to presentation he had operated for the first time in the absence of failing vision. The patient, a young woman, showed early signs of acromegalia, and in order to prevent the progress of the disease with its resulting uncomeliness, he advised her to have the operation. This is the first case in which operation has been performed when the indication for it was not loss of vision. If the sphere of indication for surgical intervention is eventually widened to include acromegalia or the Fröhlich syndrome, the activities in this field will be very much increased.

The criterion for operative intervention now and always will be the presence or absence of optic atrophy and its degree. Distortion of the optic field is a matter of secondary importance, because since it is always due to pressure or to blockage, it might disappear within an hour of the operation.

It is too soon to forecast what may be the results of operation for the arrest of acromegalia or other forms of pituitary dysfunction, but in regard to headache, the results of operation are inevitably satisfactory.

The crucial test, of course, of the efficiency of surgical intervention in disease of the pituitary body has to do with vision. What may be expected as a result of operation? It all depends on how much of the nerve or chiasm is atrophied at the time of the operation and how far advanced the atrophy may be. As a matter of fact, almost 50 per cent of the patients are already blind in one eye, with rapidly failing vision in the other when they come to the clinic. Obviously it would not be fair to charge the operation with the 50 per cent failures, because vision could not be restored in these cases.

Generally speaking, the results of operation may be classified according to the degree of atrophy present before operation: group 1, vision may be fully restored; group 2, hemianopia may persist, but vision in the nasal field may be restored or improved, and group 3, hemianopia may persist, and visual acuity of the nasal field may not be improved but may be sustained. These three alternatives summarize the possibilities of surgical intervention, and which of the three will maintain after operation is neither a matter of surgical skill nor of surgical procedure.

The technic of operation is a matter of little interest to the ophthalmologist, however, a technic has been elaborated which the presenter believes will be generally accepted. By this method, which he has been using for the past year, he operated on ten consecutive cases without a death. The minutiae of the technic are not of general interest, but what is of interest to all is the fact that a technic for approaching and dealing with the pituitary body has been elaborated which has minimized the hazard of operation, and if operation is not postponed too long, which may restore vision to normal and maintain it.

In conclusion a number of interesting lantern slides, illustrating the results in some of his cases, were shown.)

THE OPHTHALMOLOGIC ASPECTS OF PITUITARY TUMORS. DR. T. B. HALLOWAY.

The relation of certain vascular structures to the optic nerves, chiasms and tracts was discussed, and reference was made to the various ocular manifestations encountered in disease of the pituitary body. A

series of slides was shown depicting the successive changes in the optic field from the superior temporal slant to the obliteration of the remaining field, which in the experience of the presenter is usually in the superior nasal quadrant. Attention was called to the necessity of repeated examinations in these cases, as marked changes, independent of any treatment, are frequently noted in short periods of time.

(Some of these cases were of a condition to produce a Wernicke pupillary sign, but the presenter had never encountered it in this or in any other condition, and he believed that it could not be elicited by any of the convenient clinical methods now available.)

DISCUSSION

Dr. C. H. FRAZIER: In my series of cases of pituitary lesions there were three or four which were called "pseudo tumor;" that is, cases with all the earmarks of a solid tumor and with the characteristic distortion of the optic field. The pathologic factor in these cases was a suprasellar collection of fluid, the evacuation of which sufficed to give relief. One of these was under observation for eight years.

ROYAL SOCIETY OF MEDICINE, LONDON, SECTION OF OPHTHALMOLOGY

H. DICKINSON, *Reporter*

Feb. 13, 1931

MR. EIMORE BREWERTON, F.R.C.S., *President, in the Chair*

EPISCLERITIS DUE TO FOCAL SEPSIS. MR. A. F. MACCALLAN.

A man, first observed on Dec. 22, 1930, had had episcleritis in the left eye at intervals for twelve years, and had had an attack in the right eye on December 15. An old iritis was also present. No changes were seen in the fundus. The patient had been examined by a dental surgeon who removed five defective teeth. A rhinologist punctured the antrum, which yielded pus. There was still a good deal of sepsis in the antrum, and the tonsils and ethmoidal cells were also septic. Within a week, treatment will be given to clear up these conditions.

SHRUNKEN STUMP. MR. M. S. MAYOU.

At a clinical meeting of the Section of Ophthalmology a man had been shown who had iridocyclitis in one eye, and on the other side a shrunken stump, which looked as if it were the residue after a Mules' operation. He had been in the Moorfields Eye Hospital six months before, but no operation had been performed. Since then the stump of the eye had been removed and examined microscopically. The edges of the sclera were doubled in, and in the sections some iridocyclitis was noted in the anterior part of the globe. In the posterior part there was a melanotic sarcoma (exhibited). The growth was advancing from

the choroid. It was of comparatively recent origin, and there was no degeneration in the cells. (Cases of shrunken globe in the literature were cited.)

DISCUSSION

MR. BREWERTON: The case shows the advisability of removing a shrunken globe; fortunately for this patient, that has been done.

PECULIAR OPACITY OF THE CORNEA. MR. J. D. CARDELL.

(A woman was seen who had a peculiar opacity of the cornea. There was no history of a similar disease of the eye in any other member of the family. In both corneas there were a number of grayish-white opacities, chiefly in the center. Confluent patches in places gave the appearance of snowflakes. The surface of the corneas was smooth, and the fundi were normal. There was a mixed astigmatism. Vision was 6/18 in the right eye and 6/36 in the left; it was slightly improved by glasses. Excellent stereoscopic photographs were shown. The opinion was expressed that the condition was a hyaline degeneration of the cornea.)

DISCUSSION

MR. HAROLD GRIMSDALE: I showed a similar case two years ago, which I had been watching for twenty years. A man had vision of 6/15, but was bothered by the roughness of the corneas. An antiseptic ointment was the only treatment used. I do not think that treatment had any effect on the opacities.

RETINITIS PROLIFERANS COMPLICATED BY RETINAL DETACHMENT. MR. J. H. TAGGART.

A man, aged 68, came to the hospital complaining of having seen black spots before the left eye for two months. The right fundus was found to be arteriosclerotic, and there were numerous punctate hemorrhages and small exudates on the same side. It seemed to be an early stage of retinitis proliferans. In the left eye the usual anatomic landmarks were almost obliterated.

DISCUSSION

MR. BREWERTON: I consider the primary cause of the trouble to be vascular disease.

MACULAR HEMORRHAGE. MR. EUGENE WOLFF.

A woman, aged 78, had a macular hemorrhage in the right eye, and in the left eye senile macular exudative retinitis. She was first seen in May, 1929, when she gave a history of central scotoma in the left eye, of sudden onset. By August of that year the retinal condition had developed (a drawing was shown). There was a typical, large, whitish, slightly raised area in the macular region, with outlying black and white rays. A fortnight before presentation there had been an extensive hemorrhage in the right eye. This condition might be, and had been, mistaken for a new growth. Mr. Devonport had suggested that the condition was due to a hemorrhage into the internuclear layer.

DISCUSSION

MR. M. HEPBURN: In my opinion, these cases are generally choroidal in origin.

MR. J. H. FISHER: This hemorrhage could not have been primarily intraretinal. I consider that it was subretinal, occurring between the retina and choroid. There was no conspicuous atrophy of any fibers of the optic nerve in its temporal half.

MR. RAYNER BATTEN: A case that I watched for many years presented the same appearance. The fine retinal vessels in the macular region seemed to be covered by some clear fluid.

MR. HUMPHRY NEAME: The pathologic evidence is strongly in favor of its retinal origin, the hemorrhage tracking through into the subretinal space.

MR. R. A. GREEVES: Hemorrhages are not necessarily a feature of these cases. Sometimes one sees masses of exudate without hemorrhage.

A CASE OF RETROBULBAR NEURITIS MASKED BY CHOROIDITIS AND DUE TO LATENT SINUSITIS. MISS ROSA FORD.

(A woman, aged 40, complained, in 1923, of headache and blindness. After many examinations and treatments she responded to persistent glycerin drainage of the nasal accessory sinuses, without operation, though the usual signs of their involvement were lacking and rhinologists had failed to detect disease. At first the patches of choroiditis in each eye were thought to be a sufficient cause for the blindness. Since March, 1930, however, her sight had been largely restored though the choroidal patches remained almost unchanged. Pictures of the fields at different dates were shown. The condition was considered as retrobulbar neuritis because the pallor of the outer half of the left disk suggested an actual neuritis on the left side. The defects in the fields were believed to be due mainly to pressure on the nerves from inflammatory edema. Fields projected on the screen showed that after the seven weeks' nasal drainage there was a marked widening.

Vision in the right eye had never been higher than 6/12 for three years, but it was now 6/6. Vision in the left had been 6/60 for six months; it was now 6/24. Recovery of sight was accompanied by relief from pain. The patient was able to resume her work as a parlor maid and, at the time of presentation, had been working for eight months without disability.

Two important points emerged from the study of the case. The first was that behind the obvious choroiditis lay an unsuspected and more dangerous retrobulbar neuritis. The second was the prompt response to drainage of the sinuses and the permanence of the result. The diagnosis of the principal cause was based on other cases in which contracted visual fields were an accompaniment of nasal sepsis. Moreover, the pain was a confirmatory feature, for neither retrobulbar neuritis nor choroiditis causes pain, whereas sinusitis does.

It was remarkable that in this case all the usual signs of sinusitis were absent, so that not even rhinologists made the correct diagnosis.

When roentgenograms showed a suspicious condition of the right antrum, the washing out of this cavity resulted in the return of clear fluid.

From a study of this case it was concluded that the diagnosis of closed sinusitis should be investigated and properly worked out. The scotometer gave valuable indications.)

DISCUSSION

MR. RAYNER BATTEN: This patient was under my care for several years, and I wish to congratulate Miss Ford on her diagnosis and treatment. The retrobulbar neuritis could be regarded as proved. The trouble was the sinusitis, especially as the usual indications were absent. If rhinologists fail to detect the condition what is the ophthalmologist to do? The paper should be read before rhinologists.

MR. RANSOM PICKARD: In cases of this kind the report from the rhinologist is generally negative; he apparently considers that if there is no pain there is not likely to be an infection of the sinus. In the present case was pus seen at the beginning of the treatment?

MISS FORD: My experience as to the reports of rhinologists in these cases is similar to that of Mr. Pickard. The nose was packed with 6 inches (15 cm.) of gauze soaked in equal parts of glycerin and water to which was added a 10 per cent solution of mild silver protein. This was kept in the nose from three to five hours daily.

RECURRENT VASCULAR KERATITIS OF UNKNOWN ORIGIN. MR. J. H. DOGGART.

In a series of twelve cases, patients who were suffering from recurrent corneal attacks, in which the formation of superficial new vessels was the chief feature, seemed to be free from the usual causes of such formation, i. e., phlyctenular disease, trachoma, acne rosacea, keratitis and trichiasis. The ages of these patients ranged from 18 to 62, and though three of the seven male patients had long worked in a dusty atmosphere and several had defective teeth, no definite constant occupational factor was to be noted. Of the women, one had had long-standing polyarticular arthritis and another had had a number of complaints, including cholecystitis, gastric ulcer and mastoiditis.

In four of the cases the trouble began with a marginal ulcer of the cornea, and in five others there were preceding attacks of conjunctivitis. In three cases there was keratitis without ulceration at first, though all showed ulceration at some stage. A long interval elapsed before the implication of the second eye.

The cornea was seen to be invaded by superficial vessels around its whole circumference. In the absence of ulceration the pain was not severe. The vessels never became so attenuated as to resemble the fine strands remaining long after interstitial keratitis or trachomatous pannus. With each attack the vessels crept nearer the center of the cornea. In three cases calcareous changes occurred; one showed a deposit of superficial crystals. The surface of the cornea was always somewhat roughened, owing to the large size of the vessels and their superficial situation. In advanced cases the cornea lost some of its sensitiveness.

In the diagnosis the various conditions already named must be excluded, and the cornea must be examined to exclude sclerosing keratitis. Acne rosacea might cause confusion if the cornea was involved before the rash appeared.

The results of treatment had been disappointing. Though ordinary methods caused the ulcers to heal fairly readily, and though a non-ulcerative attack could be somewhat relieved by the wearing of dark glasses and the application of mild lotions, it was only a question of time before a relapse occurred. In three instances there was no history of trauma to the eye.

The Wassermann reaction was negative in the cases in which the test was performed. The contents of the conjunctival sac of one patient revealed at different times the following organisms: *Bacillus xerosis, Staphylococcus albus* and *aureus,* pneumococci and streptococci. The real cause, however, was unknown. In a middle-aged man recurrent vascular keratitis followed some time after naphthalene burns of the eyes; his condition closely resembled that of these patients. Mustard gas burns of the eyes, which at first seemed to be of only moderate severity, later caused severe relapsing keratitis with the formation of many new vessels.

DISCUSSION

MR. BREWERTON: Has Mr. Doggart ever tried the old-fashioned procedure of peritomy in these cases? As this is a bilateral condition, the procedure could be tried on one eye, the other being kept as a control.

MR. RANSOM PICKARD: I had a case of relapsing keratitis in which I performed peritomy on one of the eyes. I believe that it did some good, but not as much as I had expected.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

W. F. C. STEINBUGLER, M.D., *Secretary*

Feb. 16, 1931

ERNEST F. KRUG, M.D., *Chairman*

A CASE OF TUBERCULOUS KERATITIS: FISTULA OF THE CORNEA; REPAIR. DR. BEN WITT KEY.

This article will appear in a later issue of the ARCHIVES.

DISCUSSION

DR. MALCOLM CAMERON ROSE: I think that diphtheria antitoxin might have slowed down the destructive process if Dr. Key had used it for eight or ten weeks with Dr. Reese's cautery mixture.

DR. BEN WITT KEY: I rather anticipated that perforation would take place, and I thought that perhaps one would be justified in trying to trephine the corneal substance over the perforation with the Elschnig

corneal trephine, thus transplanting corneal substance directly in an effort to close the perforation permanently and make the eye look better. Descemet's membrane is absent at this point, and since it does not regenerate but bridges over the defect, it is questionable whether this operation would succeed.

The clinical course of this case shows the importance of making a large conjunctival flap before perforation of the descemetocele takes place.

ANGIOMA VENOSUM OF THE ORBIT. DR. JOSEPH S. HORY.

In C. R., a girl, aged 15, first seen on Jan. 8, 1931, severe temporal headaches had developed seven years before, with marked swelling in the region of the left lacrimal gland when she bent over; the swelling disappeared when she stood erect. About a year before examination the headaches became localized over the left frontal region and radiated into the left eye. Three months before, they became severe, and dizziness appeared. Two months later, she experienced pain and discomfort when she lay down. At this time a tender spot appeared in the left parieto-occipital region.

Examination showed a swelling of the upper left lid when she bent over which disappeared when she was in the erect position. On everting the lid a vascular swelling was seen lying in the position of the lacrimal gland. The tissue presented a cavernous angiomatous appearance. There was a depression in the left temporal region which caused pain on pressure; also a second one in the left parieto-occipital region which, in addition to being sensitive, enlarged when the patient bent her head backward. Laboratory examinations gave negative results; a roentgenogram of the sinuses was normal; a roentgenogram of the left orbit showed a slight suggestion of thinning of the frontal bone and considerable dilatation of the diploe on this side, possibly indicating beginning osteomyelitis.

DISCUSSION

DR. MARTIN COHEN: In regard to Dr. Hory's paper, I presented at a previous meeting a similar case of orbital cavernous hemangioma of the conjunctiva of the upper lid. All microscopic specimens in this case showed numerous independent blood spaces containing red blood cells with a few white blood corpuscles. These channels were lined with endothelium, and were surrounded with hyperplastic connective tissue owing to the chronic inflammation. The mass was encapsulated.

Roentgen treatment might produce retrogression of the mass.

A CYST OF THE IRIS. DR. A. E. TOWN (by invitation).

In a middle-aged man with blindness and a large ciliary staphyloma of the left eye, routine examination showed a small pigmented mass on the posterior surface of the iris of the right eye. Vision in the latter eye was normal and the Wassermann reaction 2+. There was no history of trauma or ocular disease. The diagnosis of cyst was made because of the translucency and tremulousness of the mass. Antisyphilitic treatment was instituted, and it was decided to enucleate the left eye in the hope that pathologic examination might supply some valuable information.

DISCUSSION

Dr. W. Guernsey Frey: Has Dr. Town any explanation for the fact that the tension varies from 30 to 60?

Dr. Ernest F. Krug: That was in the other eye.

Dr. Mark J. Schoenberg: I wish to ask whether instillations of cocaine or ephedrine have been tried. If the cyst involves the posterior layers of the iris one would expect a diminished dilatation of the pupil corresponding to the impairment of function of the dilator pupillae in the sector of the iris involved.

Dr. A. E. Town: An explanation cannot be given as to why the tension varies in the eye that has had a staphyloma. The tension in the eye that contains the mass, the cyst or sarcoma, is within normal limits. I am sorry that the pupil was not dilated with cocaine or ephedrine; just homatropine was used.

A Case of Traumatic Pulsating Exophthalmos (Postoperative). Dr. Martin Cohen.

C. H., a man, aged 23, was presented for the third time; he had first been shown on Nov. 21, 1928, and then on Jan. 21, 1929. On Aug. 31, 1928, he sustained a fissured basal fracture on the right side of the skull. He regained consciousness after a few days, the left eye being proptosed. He complained of loud noises in the head. When he was first seen at the Manhattan Eye and Ear Hospital, about three months later, the left eye was proptosed 7 mm. and free from any inflammatory reaction. Vision was 20/30. Pulsation was felt over the eyeball. A diagnosis of traumatic pulsating exophthalmos was made. A cervical truss was worn over the carotid artery for a short time, but an operation was resorted to two weeks later. The internal carotid was tied and the patient left the hospital after two weeks. Three months later, the cephalic bruit returned. Ligation of the common carotid was performed a year after the recurrence of the bruit. Three months later, a third operation became necessary because the noises in the head returned within two weeks after the common carotid was ligated. This was probably due to the establishment of collateral circulation. The third operation consisted of an incision in the supra-orbital ridge, dividing the orbital septum and exposing five pulsating veins. These were ligated, and during the following nine months there was no return of the bruit. The extent of the exophthalmos was 3 mm. and there was a slight deviation upward and outward. The tension and fields were normal.

A New Method for Studying the Normal and Pathologic Surface Anatomy of the Eye. Dr. Mark J. Schoenberg.

This article will appear in a later issue of the Archives.

Proptosis as a Diagnostic Problem (Lantern Slides). Dr. Ralph I. Lloyd.

Certain forms of proptosis occur in infancy, others in childhood and still others in adult life. In addition, there are some which appear at almost any period. Sarcomas may develop in the eye early or late in

life, and orbital cellulitis follows ethmoidal disease even in very young children despite the idea that these cells are not developed until about the age of 6. Numerous lantern slides were shown demonstrating various types of proptosis, included in which were avulsion of the eye during delivery due to a contracted pelvis, proptosis after delivery with spontaneous recovery, protrusion due to hemorrhagic disease of the newborn, and proptosis due to meningocele, chloroma, mucocele, infection of the frontal sinus, Paget's disease and osteoma in adults. At the end of the series, a slide, taken from Bartisch's book and depicting the instruments and method of operating for exophthalmos in 1583, was shown.

THE CIRCULATION OF THE AQUEOUS DR. JONAS S. FRIEDENWALD (by invitation).

(This is the report on a series of experiments performed in collaboration with Dr. H. F. Pierce in the study of the circulation of the aqueous. By placing a needle in the anterior chamber of a dog's eye, under general anesthesia, and blocking the normal channels of outflow with colloid particles, it was possible to obtain measurements of the rate of formation of the aqueous at normal intra-ocular pressure. The flow was found to be about 1 c.mm. a minute. In a case of congenital microphakia with dislocation of the lens into the anterior chamber and blocking of the pupil, resulting in secondary glaucoma, it was similarly possible to estimate the rate of flow, which proved to be of the same order of magnitude. Combining these observations with the well known data concerning the chemical composition of the aqueous, one arrives at the conclusion that the aqueous is formed mainly from the ciliary process by a mechanism of ultrafiltration. Evidence was presented, however, to show that the mechanism of formation was somewhat more complicated than had heretofore been supposed.

Attention was then directed toward the mechanism of outflow through Schlemm's canal. It was found that the outflow takes place under the influence of osmotic forces, due to the presence of blood plasma in Schlemm's canal. The outflow mechanism can take care of ten times the normal circulation with a rise of only a few millimeters in intra-ocular pressure. It was shown that the circulation of blood through the ciliary capillaries and through Schlemm's canal was subject to independent fluctuations, so that the flow through Schlemm's canal is able to compensate, in a large measure, for changes in the rate formation of aqueous, owing to changes in general arterial or venous pressure. In this way, the outflow mechanism was found to act as a safeguard, protecting the eye from marked changes in intra-ocular pressure, such as would otherwise occur in general disturbances of the circulatory balances.)

DISCUSSION

DR. BEN WITT KEY: I think that we all appreciate the study that Dr. Friedenwald has made of this subject in an effort to explain the circulation of the aqueous. I should like to ask what he means by the dynamic system or factor; is it a suction effect on the aqueous by the flow of the blood stream, or is it only osmosis?

DR. MARTIN COHEN: I am sure that we are all grateful for this scientific presentation. I have always been under the impression that Duke-Elder does not consider the aqueous stagnant, but that there is circulation. I should like to ask whether, according to Duke-Elder, temperature plays any part in the circulation of the aqueous; whether differences in temperature between the anterior portion and the posterior portion of the aqueous might not be a factor in the circulation of the aqueous.

DR. MALCOLM CAMERON ROSE: I should like to ask Dr. Friedenwald if he thinks it possible that the blood and the other fluids of the system are overloaded, and that if one used almost weekly a proprietary diuretic and stimulant oil this overloading would pass out through the kidneys and bowels. Might this not be as safe a way as any to obviate the overloading? Possibly the trouble in cataracts is caused by a deposit being formed through life, and appearing when some of the secretions are not so active. Would not the diuretic mentioned prevent both glaucoma and cataract?

DR. JOHN NORRIS EVANS: I believe that it was Magitot who suggested that the retina and iris might play some part in the equilibrium of the intra-ocular pressure. Does Dr. Friedenwald consider that true?

DR. JONAS S. FRIEDENWALD: I am not sure that I shall be able to answer all these questions satisfactorily.

Dr. Key asks whether suction as well as osmosis plays a part in the outflow of aqueous through Schlemm's canal. I think that I can say with considerable certainty that the outflow is due to osmosis alone. Suction cannot act in such a way as to cause fluid to flow from a place of low pressure to a place of higher pressure.

In reply to Dr. Cohen's interesting question, I have here a quotation from Duke-Elder about that particular point. In his monograph in the *British Journal of Ophthalmology,* "On the Nature of the Intra-Ocular Fluid," he said: "While such osmotic fluid interchange occurs in both directions throughout the eye as a whole, the location of the greatest pressure head in the circulation in the region of the distribution of the long posterior ciliary arteries will determine the greatest outward diffusion from the ciliary body and iris, and the position of the canal of Schlemm far down the venous pressure gradient, with its wall resembling the capillary endothelium, will favor an inward diffusion at the angle of the anterior chamber. The pressure equilibrium which has been indicated at the canal of Schlemm will allow changes of pressure, such as will be produced by muscular contraction and sudden alterations in the vascular pressures, to initiate a minimal and temporary through-and-through circulation."

In other words, Duke-Elder said that such circulation as occurs goes from the ciliary processes into the ocular cavity, and out of the anterior chamber and through Schlemm's canal, but that this circulation is merely temporary and minimal. Those are the qualifying adjectives which he uses.

One might well ask: If the pressure in the ciliary capillaries is definitely higher and the pressure in Schlemm's canal definitely lower, why should the exchange of fluid be intermittent or temporary? The difference in pressure levels is sufficient to account for a continuous and

appreciable flow of fluid. It is in this particular point that I differ with him in his conclusions. I think that we are in agreement as to the premises.

I think that there is no doubt that a thermal circulation of the aqueous exists within the anterior chamber. In the anterior layers of the anterior chamber the aqueous falls, owing to cooling, and in the back of the anterior chamber it rises, owing to heating. This thermal circulation goes round and round in a circle and has nothing to do with the actual amount of fluid that flows into and out of the anterior chamber. This thermal circulation can therefore have no direct connection with the problem of glaucoma. For this reason I left it out of the discussion. It seemed to me that our aim in studying the aqueous is to find the weak spots in the mechanism governing its circulation. Until this mechanism is known, at least in rough outline, one cannot have any idea as to where glaucoma begins, and it is with a view to solving that problem that all these studies have been undertaken.

In regard to diuresis and catharsis, I think that their influence on the general health of the patient is no doubt important, but the influence of catharsis on the intra-ocular pressure has not been found to be of any significant magnitude. While it may have an indirect effect, there are no means at the present time of gauging its value in relation to glaucoma and cataract.

Dr. Evans raises the question as to whether the retina and iris play a part in the equilibrium of intra-ocular pressure. Magitot was of the opinion that the formation of aqueous was the work of the glial cells of the retina; that it was formed once and for all time in infancy. I disagree with this conclusion for a great many reasons. First, it seems clear, from these experiments and from the vast clinical evidence, that there is a circulation of the intra-ocular fluid. Second, if the retina were an important factor in the formation of the aqueous, one would expect the intra-ocular pressure to fall when the circulation of the retina is interfered with by embolism of the central retinal artery, because with the collapse of the circulation of the retina, no further formation could take place. Contrary to this supposition, one does not see any change in the pressure of the eye in cases of embolism of the central retinal artery. The same is true, in a more complicated fashion, in relation to thrombosis of the central vein. It is true that glaucoma often follows on this accident, but it does not appear until from four to six weeks after the vascular accident in the retina, and for this reason one cannot attribute it to any sudden change in the dynamic balance of the circulation of the retina. It may be due to some secondary phenomenon which is as yet obscure. These two facts rule out the retina from any important part in the circulation of the intra-ocular fluid. On the other hand, it is true that there may be some diffusion of fluid around the central vessels in the optic disk and out into the meninges. This outflow seems to be connected mainly with the tissue juices of the retina, and has nothing to do with the general circulation of the aqueous. In choked disk, when this outflow is obstructed, one sees no disturbance in the equilibrium of the intra-ocular pressure.

If the iris is completely excised the eye can regain a normal pressure. In the cases of congenital aniridia one is not confronted with any abnormality in the intra-ocular pressure. Experiments in which dyes

have been injected into the anterior chamber do not show an appreciable flow into or out of the iris stroma. In the experiments that I reported, in which serum was injected into the anterior chamber, if there had been any considerable absorption of fluid by the iris, one would expect the serum to seep into the iris stroma and stay there. This particular point was investigated with some care. The eye was allowed to remain in equilibrium with serum in the anterior chamber for an appreciable length of time. The stopcocks were then closed so that no further exchange of fluid could take place, and without removing the needles, we excised the eyeball, put it promptly into a fixative solution and subsequently made histologic sections. The coagulated serum of the anterior chamber could be seen without difficulty, but it penetrated only to a minimal degree into the iris, which was not discolored by the presence of coagulated serum. For this reason I think that the iris also plays a minimal part in the circulation of the aqueous. It is true that if there is an inflammation of the iris, the balance may be thrown in an entirely different direction. Here I am speaking only of the normal equilibrium. The cornea has sometimes been thought of as a possible mode of egress of the aqueous, but I think that the recent work of Fischer shows that no appreciable amount of fluid goes from the anterior chamber into the corneal stroma.

Book Reviews

ACTA OF THE JAPANESE OPHTHALMOLOGICAL SOCIETY, OCTOBER, 1930. Tokio: Ophthalmological Institute of the Imperial University.

This number of the *Acta of the Japanese Ophhalmological Society*, a voluminous volume of nearly 700 pages, commemorates the fifteenth year of teaching of Professor Ichikawa, and furnishes an excellent photograph of the recipient of this festschrift. There are fifty articles published in Japanese, many with beautiful illustrations, and a short summary of these articles in German. Particular attention may be drawn to the following:

Dr. S. Ibata, of Kyoto, discusses avitaminosis in albino rats and gives a description of the changes in the retina observed by lipoid staining. Young white rats were fed with a diet poor in vitamin A, so that they were suffering from avitaminosis; the eyeballs were subjected to histologic examination. The author has also endeavored to determine whether there is any morphologic condition between the light and the dark adapted retina. In this work he used various lipoid stains. The result showed that the rods and cones of these animals had lost much of their lipoid content, and there was also a disturbance of the physiologic increase of their lipoid content in the dark. Dr. Ibata believes that these results show that conditions in avitaminosis may be due to a disturbance of the cells and not to that of the pigment epithelium.

Dr. S. Amano writes on the tonus of the vegetative nervous system in chronic glaucoma. To determine the relation of glaucoma simplex to disturbances of the vegetative nervous system, the author examined three cases according to pharmacodynamic, biochemical and roentgenologic methods, and concluded that vagotonia is usually present in this condition.

Dr. Kawashima studied the experimental transfer of infection from eyeball to eyeball with smallpox virus. When smallpox virus is injected into the suprachoroidal space of one rabbit's eye it produces an inflammation not only of that eye, but also of the second eye, in nearly 100 per cent of animals. The incubation period is about eight days. Papillitis and then iritis are the first manifestations in the second eye. The transfer takes place along the sheath of the optic nerve, as von Szily showed with herpes virus. Inoculation with chiasmal tissue, optic nerve and choroid of the second eye gives a positive result. The cerebrospinal fluid is frequently found affected.

The pathologic changes in a clinically observed case of syphilitic neuroretinitis are reported by Dr. S. Suganuma, of Tokyo.

Dr. S. Mori writes on the pathologic investigations of the eyes of diabetic patients.

In cases of diabetes, signs of swelling and deposition of glycogen are observed in tissues related to the intra-ocular fluid. The epithelium of the posterior iris presents hydropic swelling with infiltration of glycogen; there are deposits of glycogen in the iris, in the epithelium and endothelium of the cornea and in the epithelium of the pars plana retinae.

Sclerosis of the arterioles and capillaries in the retina and optic nerve occurs principally at the posterior pole of the eyeball where the ophthalmoscopic changes predominate.

The permeability of the sclerosed arterioles and capillaries allows an increased exudation of substances which are toxic to nervous elements and affect the ganglion cells and nerve fibers in the retina and optic nerve in the form of an intoxication amblyopia. This explains the primary degeneration of the ganglion cells in the macular region and the primary atrophy of the optic nerve.

Dr. Hiwatari writes of the involvement of the fornix and plica semilunalis in spring catarrh.

Five cases of Vossius ring opacities are reported by Dr. Higashi. The opacity was found to consist of numerous dots situated on the anterior surface of the lens, made up of red blood cells, thus agreeing with the observations of Hesse.

Dr. Yamane writes on the experimental investigation of retinal detachment. His results substantiate Marx's treatment for retinal detachment with a salt-free diet. Subconjunctival injections of a hypertonic solution of sodium chloride are not harmful, except for the hyperemic effect on the choroid.

Dr. R. Okumura discusses operative treatment in the prodromal stages of glaucoma. He advocates operation for glaucoma in the prodromal stage, preferably by peripheral iridectomy and iridodialysis. Ichikawa makes a hole in the peripheral iris, as does Curran, and draws the iris downward with the keratome.

Dr. Ashikaga considers the blood picture in certain diseases of the eye. In tuberculous diseases of the eye the large lymphocytes are increased, as they are in syphilitic cases in which there are, in addition, an increased number of monocytes. The oval form of the blood platelets was especially noticeable in syphilitic disease. The author was not prepared to give this any diagnostic significance.

Dr. Ogata discusses the Denig transplantation for trachomatous pannus. The author reports satisfactory results which he ascribes to the isolation of the cornea from the trachomatous conjunctiva, but was not prepared to admit that the transplanted mucous membrane is immune against trachoma.

Dr. Hayashi gives reports of cases of spring catarrh.

Dr. Funaishi considers dark adaptation.

Dr. Imachi discusses the contents of the lumbar fluid in diseases of the eye, and the diagnostic and therapeutic value of lumbar puncture. He reports the results of 1,113 lumbar punctures performed for diseases of the eyes grouped according to the diagnosis.

Increased pressure was found in 55 per cent of the cases of syphilitic diseases of the eyes, and in 61.4 per cent of the nonsyphilitic cases; in other words, this is of no value for the differential diagnosis. The other changes, however, have great importance for the etiologic diagnosis of syphilis; they were present in 86.2 per cent of the cases, though all of Nonne's four reactions (globulin, pleocytosis, blood and spinal Wassermann) need not be positive. An exception was the syphilitic retrobulbar neuritis, in which the spinal fluid is usually negative. The results in optic atrophy and paralysis of the ocular muscles are about the same. In other syphilitic cases, such as iridocyclitis, keratitis, etc., there are fewer posi-

tive observations of the spinal fluid. The rachidial quotient is generally higher in inflammatory diseases of the optic nerve than in noninflammatory conditions and in tumor of the brain. Therapeutically, lumbar puncture is of great value in papilledema from serous meningitis and in a form of acute retrobulbar neuritis.

The subretinal fluid in idiopathic detachment of the retina is discussed by Dr. S. Yamamoto. Biochemical examination has shown that (1) the subretinal fluid in detachment is a transudate from the choroidal vessels, and that (2) the chloride retention in the subretinal fluid depends on the particular changes in the salt exchange of the choroidal vessels.

These papers bear witness to the remarkable industry and the scientific ardor that our Japanese colleagues possess. A. K.

BULLETIN OF THE NEUROLOGICAL INSTITUTE OF NEW YORK. Pp. 157. Baltimore: Williams & Wilkins Company, 1931.

The first issue of the *Bulletin of the Neurological Institute of New York* has appeared. This journal is published under the auspices of the Board of Trustees, by the Committee on Research and Publication, and is edited by Oliver S. Strong, Ph.D.

The new research that will be undertaken at the Neurological Institute, thanks to the research funds, and the enlargement of other investigations now under way, in addition to the clinical and laboratory reports, will be of such volume as to warrant the creation of a special journal. This journal will appear three or four times a year. The investigations that rest on morphologic, physiologic or pathologic studies, or that can be experimentally controlled, will be given preference.

The present number contains 157 pages, and the contents is as follows:

The Meningeal Fibroblastomas (Dural Endotheliomas, Meningiomas, Arachnoid Fibroblastomas): Their Origin, Gross Structure, Blood Supply, and Their Effects Upon the Brain: Principle of Technique for Their Removal, Charles A. Elsberg, M.D.

The Value of Brain Lipoids as an Index of Brain Development, Frederick Tilney, M.D., and Joshua Rosett, M.D.

A Clinical and Pathological Study of Two Cases of Obstruction of the Aqueduct of Sylvius, Samuel T. Orton, M.D.

Two Cases of Tumor of the Post-Cranial Fossa Causing Visual Hallucinations, Edwin M. Deery, M.D.

Studies on the Pathogenesis of Multiple Sclerosis: II. The Identification and Properties of an Acid Producing Substance Found in the Blood, Richard M. Brickner, M.D.

The Localizing Significance of Impaired Respiratory Movements in Lesions of the Spinal Cord, Walter O. Klingman, M.D.

The Effects of Absinth on the Cat, Following Bilateral Adrenalectomy, Helen C. Coombs, M.D.; S. Bernard Wortis, M.D., and Frank H. Pike.

A Critical Survey of the Patients Admitted Into and Discharged from the Neurological Institute from January, 1930, to June, 1930, John A. Malcolm, M.D.

The print is easy to read, and the paper has an agreeable finish except when illustrations require a smooth finish. The editors are to be congratulated on a scholarly and dignified journal. A. K.

INTRODUCTION A L'ÉTUDE DES HYPERTENSIONS OCULAIRE. By DR. GEORGES BONNEFON, Bordeaux. Price, 45 francs. Pp. 149. Paris: Gaston Doin, 1931.

In this modestly entitled work the author presents the results of much clinical and experimental study with conclusions based on the known data from the ophthalmologic practice of other authorities. His main thesis is that there is no one "glaucoma" or even one "hypertension," but various conditions of stable or unstable equilibrium between "two mobile fluids contained within and separated by permeable walls," so that hypertension may be static or equilibrated, dynamic or unbalanced and, finally, compensated. Insisting on the fallacy of a uniform denomination and on the futility of theoretic generalizations, Bonnefon points out that treatment may be medical or surgical or both, and may vary in a single form of hypertension, according to the degree of evolution. In the course of this treatise he gives interesting and instructive data on the factors determining intra-ocular tension, scleral permeability, the circulation of the aqueous, choroidal circulation, vasculohumoral equilibrium, retrobulbar injections of epinephrine in hypertension and experimental sclerotomy. His most important practical conclusion perhaps is the following: Prompt and early surgical intervention cures static hypertension by removing the cause. Any hope of ameliorating or of curing this form of hypertension by medical treatment is a delusion and a snare.

P. H. F.

Directory of Ophthalmologic Societies *

FOREIGN

British Medical Association, Section on Ophthalmology

President: Mr. E. E. Maddox, Glenartney, Poole Road, Bournemouth, England.
Place: Eastbourne. Time: July 22-24, 1931.

Oxford Ophthalmological Congress

Master: Dr. A. B. Cridland, Salisbury House, Chapel Ash, Wolverhampton, England.
Secretary: Dr. C. G. Russ-Wood, 12 St. John's Hill, Shrewsbury, England.
Place: Oxford. Time: July 8-11, 1931.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 Avenue de La Motte Picquet, Paris 7è.
Place: Paris. Time: May 4-7, 1931.

NATIONAL

American Medical Association, Section on Ophthalmologgy

Chairman: Dr. George F. Suker, 25 E. Washington St., Chicago.
Secretary: Dr. William C. Finnoff, Imperial Bldg., Denver.
Place: Philadelphia. Time: June 8-12, 1931.

American Academy of Ophthalmology and Oto-Laryngology

President: Dr. J. F. Barnhill, Miami Beach, Fla.
President-Elect: Dr. S. Hanford McKee, 1528 Crescent St., Montreal, Canada.
Executive Secretary: Dr. William P. Wherry, Medical Arts Bldg., Omaha.
Place: French Lick, Indiana. Time: Sept. 14-19, 1931.

American Ophthalmological Society

President: Dr. Arnold Knapp, 10 E. 54th St., New York.
Secretary: Dr. Emory Hill, Professional Bldg., Richmond, Va.
Place: Asheville, N. C. Time: June 1-3, 1931.

SECTIONAL

New England Ophthalmological Society

President: Dr. S. Judd Beach, 704 Congress St., Portland, Me.
Secretary-Treasurer: Dr. E. B. Dunphy, 520 Commonwealth Ave., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. Chester H. Bowers, 1136 W. 6th St., Los Angeles.
Secretary-Treasurer: Dr. Walter F. Hoffman, 817 Summit Ave., Seattle.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. Albert E. Hillis, 1115 Pacific Ave., Seattle.
Secretary-Treasurer: Dr. Francis A. Brugman, 806 Cobb Bldg., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

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* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

Sioux Valley Eye and Ear Academy

President: Dr. Claude T. Uren, City National Bank Bldg., Omaha.
Secretary-Treasurer: Dr. Frederick H. Roost, 420 Trimble Bldg., Sioux City, Iowa.
Place: Fontanelle Hotel, Omaha. Time: November, 1931.

Southern Medical Association, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Fletcher D. Woodward, Box 162, University, Va.
Secretary: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Place: New Orleans. Time: November, 1931.

Southwestern Michigan Triological Society

President: Dr. Wilfrid Haughey, 65 W. Michigan Ave., Battle Creek.
Secretary: Dr. R. H. Fraser, Battle Creek Sanitarium, Battle Creek.
Time: Third Thursday of alternate months.

STATE

Colorado Ophthalmological Society

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Ralph W. Danielson, 258 Metropolitan Bldg., Denver.
Place: First floor, Metropolitan Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive. Annual meeting in Denver, July 25, 1931.

Connecticut State Medical Society, Section on Eye, Ear, Nose and Throat

President: Dr. Dorland Smith, 836 Myrtle Ave., Bridgeport.
Secretary-Treasurer: Dr. Walter L. Hogan, 750 Main St., Hartford.
Time: May, November.

Eye, Ear, Nose and Throat Club of Georgia

President: W. L. McDougall, 50 Whitehall St., S. W., Atlanta.
Secretary-Treasurer: Dr. William O. Martin, Jr., 412 Medical Arts Bldg., Atlanta.

Indiana Academy of Ophthalmology and Oto-Laryngology

President: Dr. John W. Carmack, 23 E. Ohio St., Indianapolis.
Secretary: Dr. J. Kent Leasure, 23 E. Ohio St., Indianapolis.

Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. Gordon F. Harkness, 215 Main St., Davenport.
Secretary-Treasurer: Dr. W. F. Boiler, 105 E. Iowa Ave., Iowa City.

Minnesota Academy of Ophthalmology and Oto-Laryngology

President: Dr. John C. Brown, 350 St. Peter St., St. Paul.
Secretary-Treasurer: Dr. Hendrie W. Grant, Lowry Bldg., St. Paul.

Montana Academy of Oto-Ophthalmology

President: Dr. Lee W. Smith, 125 W. Granite St., Butte.
Secretary: Dr. J. G. Parsons, Lewistown.

North Dakota Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. B. Beeson, 232 W. De Mers Ave., Grand Forks.
Secretary-Treasurer: Dr. F. L. Wicks, Valley City.

Oregon Academy of Ophthalmology and Oto-Laryngology

President: Dr. J. W. McCollom, 346½ Washington St., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. Raymond F. Hacking, 105 Waterman St., Providence.
Secretary: Dr. Herman A. Winkler, 224 Thayer St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. Franklin H. Raley, 9 Exchange Pl., Salt Lake City.
Secretary-Treasurer: Dr. H. Leroy Smith, 1005 Medical Arts Bldg., Salt Lake City.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Fletcher D. Woodward, Box 162, University.
Secretary-Treasurer: Dr. Henry Grant Preston, Harrisonburg.
Place: Richmond. Time: May 2, 1931.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. S. S. Hall, Fairmont.
Secretary: Dr. G. A. Smith, Montgomery.
Place: Clarksburg. Time: May 19-21, 1931.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. J. Wallace Hurff, 86 Washington St., Newark.
Secretary: Dr. Earl LeRoy Wood, 31 Lincoln Park, Newark.
Place: 91 Lincoln Park South. Time: 8:45 p. m., second Monday of each month.

ACADEMY OF MEDICINE OF TORONTO, SECTION OF OPHTHALMOLOGY

Chairman: Dr. P. J. F. Houston, 34 Hurndale Ave., Toronto.
Secretary: Dr. Alexander E. MacDonald, 151 Bloor St., W. Toronto.
Time: First Monday of winter months.

ATLANTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. John R. Childs, 45 Edgewood Ave., Atlanta, Ga.
Secretary: Dr. William O. Martin, Jr., Medical Arts Bldg., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St., N. E. Time: 8 p. m., last Thursday of each month.

BALTIMORE MEDICAL SOCIETY. SECTION ON OPHTHALMOLOGY

Chairman: Dr. Angus Lloyd MacLean, Johns Hopkins Hospital, Baltimore.
Secretary: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. John N. Evans, 23 Schermerhorn St., Brooklyn.
Secretary: Dr. Michael J. Buonaguro, 589 Lorimer St., Brooklyn.
Place: King's County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday of February, April, May, October and December.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. A. F. Luhr, 40 W. North Ave., Buffalo.
Secretary-Treasurer: Dr. Thurber Le-Win, 112 Linwood Ave., Buffalo.

Chicago Ophthalmological Society

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Secretary: Dr. Richard C. Gamble, 30 N. Michigan Ave., Chicago.
Place: Medical and Dental Arts Club. Time: Third Monday of each month from October to May.

Cleveland Academy of Medicine, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. William V. Mullin, 9204 Euclid Ave., Cleveland.
Secretary: Dr. H. C. Rosenberger, 2064 E. 9th St., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. W. E. Burner, Guardian Bldg., Cleveland.
Secretary: Dr. M. P. Motto, Rose Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Maxwell Langdon, 1530 Locust St., Philadephia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. A. M. Hauer, 327 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. Albert D. Frost, 681 E. Broad St., Columbus, Ohio.
Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. B. Decherd, 1717 Pacific Ave., Dallas, Texas.
Executive Secretary: Dr. W. Mood Knowles, 1717 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Parker Heath, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. G. G. Marshall, 122 West St. Rutland, Vt.
Secretary-Treasurer: Dr. Arthur F. Holding, 142 Washington Ave., Albany.
Time: Third Wednesday of October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. J. J. Richardson, 606 Penn St., Fort Worth, Texas.
Secretary-Treasurer: Dr. R. H. Needham, 1304 Medical Arts Bldg., Forth Worth, Texas.
Place: University Club. Time: 6:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. Claude C. Cody, 1306 Walker Ave., Houston, Texas.
Secretary: Dr. J. M. Robison, Eye, Ear, Nose and Throat Hospital, Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., first Thursday of each month from September to June.

Indianapolis Ophthalmological and Oto-Laryngological Society

President: Dr. E. L. Lingeman, 241 N. Pennsylvania St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, Hume-Mansur Bldg., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. E. Eubank, Argyle Bldg., Kansas City, Mo.
Secretary: Dr. O. S. Gilliland, Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dean E. Godwin, Security Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Ferris Arnold, Security Bldg., Long Beach, Calif.
Place: Pacific Coast Club. Time: Last Wednesday of each month from September to June.

LOS ANGELES COUNTY MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Eugene R. Lewis, 727 W. 7th St., Los Angeles.
Secretary-Treasurer: Dr. J. Frank Friesen, 727 W. 7th St., Los Angeles.
Place: California Lutheran Hospital, Assembly Room. Time: 8 p. m., first Monday of each month from October to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Dr. James A. Flynn, 1511 Rhode Island Ave., Washington.
Secretary: Dr. E. R. Gookin, Medical Science Bldg., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, Exchange Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. Herbert F. Wolters, 130 Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. O. P. Schoofs, 324 E. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., third Tuesday of each month.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Hilliard Wood, 700 Church St., Nashville, Tenn.
Secretary-Treasurer: Dr. H. C. Smith, Medical Arts Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. W. R. Buffington, 211 Camp St., New Orleans.
Secretary-Treasurer: Dr. M. F. Meyer, Canal Bank Bldg., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. E. F. Krug, 12 W. 44th St., New York.
Secretary: Dr. William F. C. Steinbugler, 815 Park Ave., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. George B. Potter, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. J. C. Davis, 425 Aquila Court, Omaha.
Place: Medical Tea Room. Time: 5:15 and 7:00 p. m., third Wednesday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Edward B. Heckel, Jenkins Arcade Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Rochester Eye, Ear, Nose and Throat Society

Chairman: Dr. Clyde Heatly, 11 N. Goodman St., Rochester, N. Y.
Secretary-Treasurer: Dr. John F. Gipner, 53 S. Fitzhugh St., Rochester, N. Y.
Place: Rochester Medical Assn., 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

Pittsburgh Slit-Lamp Society

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. Emanuel U. Wallerstein, Professional Bldg., Richmond, Va.
Secretary: Dr. William R. Weisiger, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

St. Louis Ophthalmic Society

President: Dr. Martin H. Post, 508 N. Grand Blvd., St. Louis.
Secretary: Dr. Carl T. Eber, 1006 Carleton Bldg., St. Louis.
Place: St. Louis or Washington University Cafeteria.
Time: 6:30 p. m., fourth Friday of each month from October to April, inclusive.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. T. J. Walthall, 728 Main Ave., San Antonio, Texas.
Secretary-Treasurer: Dr. E. D. Dumas, 425 Medical Arts Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. W. F. Swett, 693 Sutter St., San Francisco.
Secretary: Dr. Robert C. Martin, 384 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Third Tuesday of every month except May, June, July and December.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. Paul A. Remington, Old National Bank Bldg., Spokane, Wash.
Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. Searle B. Marlow, State Tower Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. A. Harry Rubenstein, Medical Arts Bldg., Syracuse, N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.